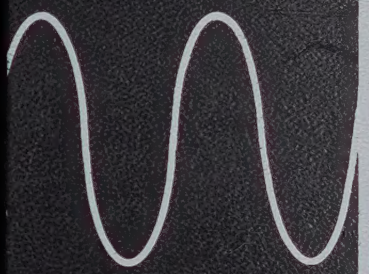
E. M. L.
File Copy



SPECTRAL DYNAMICS CORPORATION

EML
SERIAL 241

INSTRUCTION MANUAL

SD330-20

Spectrascope

REAL TIME ANALYZER

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.

DENNIS GARRETT (SERVICE)
KEN CONSTABLE (SERVICE)
83-71-7 — 565-8211

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO
8911 Balboa Avenue, P.O. Box 671
San Diego, California 92112
Telephone: (714) 278-2501
TWX: 910-335-2022

COMPANY #
83-71-7-278-2501

September 1973

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_09551

ADDENDUM

Model SD330-20 Spectrascope – Real Time Analyzer

The Model SD330-20 is basically a standard SDC Model SD330 Spectrascope – Real Time Analyzer. The "-20" added to the basic model number denotes a modification that adds an illuminated oscilloscope graticule and scale illumination control.

Externally, the modification involved a new front panel with an illuminated oscilloscope graticule and space for the SCALE ILLUM control adjacent to the OUTPUT GAIN (dB) push buttons. Figure 1 of this addendum illustrates the front panel change.

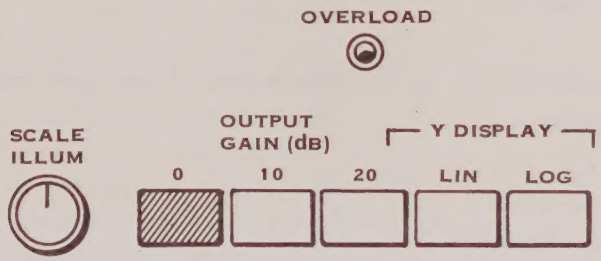


Figure 1. SD330-20 Modification, Front Panel Change

Internally, the modification involved a new power transformer, a new high-voltage power supply circuit card, a new output gain/Y display circuit card, a revised horizontal and vertical amplifier circuit card, and a new square cathode ray tube.

The operation of the instrument is not changed by the "-20" modification.

Calibration procedures in Section IV of the Instruction Manual are changed by the "-20" modifications as follows:

Page 4-2, Paragraph 4.2.3,
change Steps a., b. and c., and add Step d.,
as follows:

a. Connect DVM to A32TP1 and adjust A32R23 for 180V (175V to 185V).

b. Connect DVM to A32TP2 and observe that voltage is 87V (75V to 100V).

c. Set a Simpson 269 Voltmeter (or equivalent) to the 1600V range and connect to A32TP3 or to A32E14 and observe that voltage is –1100V (–1000V to –1250V).

d. Connect voltmeter to A32E15 and observe that voltage is +1100V (+1000V to +1250V).

Page 4-6, Paragraph 4.2.10.,
insert new Steps b. and c. after Step a.,
as follows:

b. Position the displayed baseline to –25 dB and adjust A32R20 to align the baseline and the graticule. If adjustment is out of range, reverse the twist coil leads on A32E19 and A32E20.

c. Position the baseline to –5 dB and observe. If it is not straight, adjust A32R14 for optimum geometry.

Remaining Steps b., c. and d.,
become d., e. and f., respectively.

Page 4-10, Table 4-2,
make changes as indicated to the following items:

Reference Designator	Description	Part Number/ Mfr. Designation
A26	Circuit Card, Output Gain/Y Display	10032301
A31	Circuit Card, Horiz. & Vert. Amplifiers	14358-3
A32	Circuit Card, High Voltage Power Supply	10122000
	Knob, (single index) SCALE ILLUM	20013-175
	Graticule, Oscilloscope	10122500
T1	Transformer, Power	10113800
V1	Vacuum Tube, Cathode Ray	D14-170GH (BRIMAR)

LIST OF ILLUSTRATIONS

Number		Page
Figure 1-1.	Concept of Operation	1-3
Figure 1-2.	Front Panel	1-3
Figure 1-3.	Rear Panel	1-9
Figure 2-1.	Calibration Signal	2-4
Figure 2-2.	Intensified Dots Set at Top of Each of 10 Frequency Markers	2-4
Figure 2-3.	Full-Scale Calibration Signal in MANUAL Mode	2-5
Figure 2-4.	Calibration Signal with Linear Amplitude Scale Set to Cover Full Graticule Height	2-5
Figure 2-5.	3-D Spectrum Data Display	2-9
Figure 2-6.	Instrument Setup for Obtaining 3-D Display	2-9
Figure 2-7.	Typical Plot of Unaveraged Spectra	2-12
Figure 2-8.	Typical Plot of Averaged Spectra	2-12
Figure 2-9.	Instrument Setup for Signature Ratio® Analysis	2-14
Figure 2-10.	Instrument Setup for RPM Tracking Analysis	2-15
Figure 2-11.	Typical Test Requirement for a Profile of Power Spectral Density	2-19
Figure 2-12.	Determination of Overall g rms Level	2-20
Figure 2-13.	Typical Test Requirement Showing a Flat PSD Spectrum Combined with a Periodic Signal	2-20
Figure 2-14.	Two Test Setups Used for Determining Effective (Noise) Bandwidth	2-24
Figure 2-15.	Setup for Viewing Memory Contents	2-25
Figure 2-16.	Oscilloscope Display Showing Approximate Zone of Truncation as Determined by Oscilloscope Trigger Delay	2-26
Figure 2-17.	Spectrum of 1 Cycle of a 500-Hz Signal	2-27
Figure 2-18.	Spectrum of 2 Cycles of a 500-Hz Signal	2-27
Figure 2-19.	Spectrum of 4 Cycles of a 500-Hz Signal	2-27
Figure 2-20.	Effect of Weighting Function	2-27
Figure 2-21.	Vibration Nomograph	2-30
Figure 3-1.	Simplified Block Diagram, Spectrascope	3-3
Figure 3-2.	Functional Block Diagram of Spectrascope (Sheet 1)	3-8
	(Sheet 2)	3-9
Figure 4-1.	Location of Major Assemblies	4-3

LIST OF DRAWINGS

(Located at Rear of Manual)

Circuit Card Ref. Desig.	Drawing No.	Title
A1	10044800	Clock, Assy 10045000
A2	14302	A-D Converter, Assy 14304-1
A3, A4	14308	Memory, Assy 14310-1
A5	14313	High-Speed D-A Converter, Assy 14312-1
A6	14319	Scan Mixer, Assy 14318-1
A7	15466	Sweep Oscillator, Assy 15464-1
A8	14320	Detector and Output Amplifier, Assy 14322-1
A10	14331	Display Control/Marker Generator, Assy 14330-1
A11	14326	Counter Control, Assy 14328-1
A12	14332	Counter, Assy 14334-1
A13	14337	BCD Ladder, Assy 14336-1
A14	14338	Averager A-D Converter, Assy 14340-1
A15	14343	Averager Timing, Assy 14342-1
A16	14344	Averager Divide Select, Assy 14346-1
A17	14349	Averager Memory, Assy 14348-1
A18	14350	Averager D-A Converter, Assy 14352-1
A19	14355	Low-Voltage Power Supply, Assy 14354-1
*A20	14415	Mother Board (Left), Assy 14414-1
A21	14416	Mother Board (Right), Assy 14418-1
A22	14360	Input Range (Coarse), Assy 14362-1
A23	14365	Input Range (Fine), Assy 14364-1
A24	14384	Input Assembly, Assy 14816-1
A25	14366	Operate/Calibrate, Assy 14368-1
A26	10155200	Output Gain/Y Display, Assy 10032301
A27	14372	Number of Averages, Assy 14374-1
A28	14377	Averages Control, Assy 14376-1
A29	14378	Display Functions, Assy 14380-1
A30	14383	Memory/Markers, Assy 14382-1
A31	10122100	Horizontal & Vertical Amplifiers, Assy 14358-3
A32	10121800	High-Voltage Power Supply, Assy 10122000
	10121700	Interconnecting Diagram

SERIAL _____

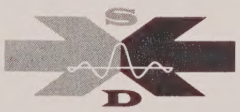
INSTRUCTION MANUAL

SD330

Spectrascope

REAL TIME ANALYZER

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.



SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

8911 Balboa Avenue, P.O. Box 671

San Diego, California 92112

Telephone: (714) 278-2501

TWX: 910-335-2022

January 1973

ADDENDUM

SD330

Automatic Reduction of Sweep Rate During Log-X Sweep

(S/N 138 THRU 187)

1.0 MODIFICATION DATA

A special circuit has been added to automatically reduce the sweep rate of the log-X sweep available at PLOTTER FREQ-X output connector on the rear panel. The PLOTTER section of the rear panel has been modified as depicted in Figure 1 to allow manual selection of the plotter log-X or lin-X output with a switch while the X-Y plotter remains connected to the same output connector (FREQ-X). The PLOTTER LOG-X/LIN-X switch activates the sweep rate reduction circuit in the LOG-X position. It is emphasized that the switch should be left in the LIN-X position except when the feature it affords in the LOG-X position is expressly desired. (The switch is manufactured by C&K; its Part Number is 7201).

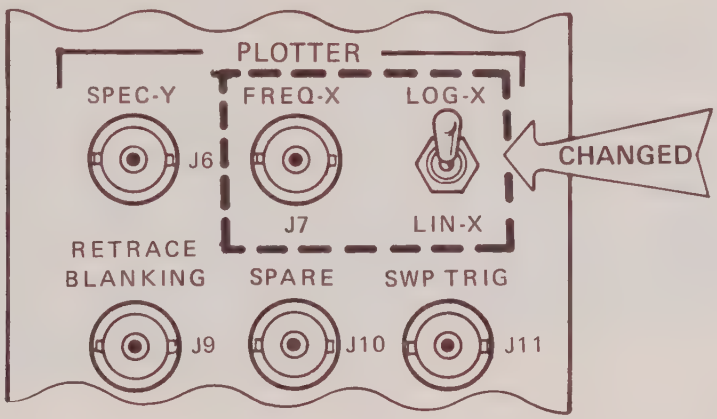


Figure 1. Rear-Panel Modification for Control of Plotter Log-X Sweep Rate

1.1 Circuit Philosophy

In the PLOTTER mode, with the PLOTTER LOG-X/LIN-X switch in the LIN-X position, total sweep time is nominally 25 seconds. But when the switch is in the LOG-X position, total nominal sweep time is doubled. This is because the sweep rate is slowed during the first 50 filter locations (20 percent of sweep) to allow the X-Y plotter sufficient time to respond to the logarithmic X-axis where the rate of change is greatest. This function is separate from sweep rate feedback (SRF) which is active for the duration of both the linear and logarithmic plotter sweeps.

2.0 OPERATION

The basic functions of the Spectrascope are not affected by the modification described in Paragraph 1.0 of this Addendum. However, the operating procedure is slightly affected but only when plotting data using the PLOTTER LOG-X output.

3.0 CALIBRATION

The modification described in Paragraph 1.0 of this Addendum affects the calibration procedures in Section IV of the Spectrascope Instruction Manual as follows:

Paragraph 4.2.4, Step a.

Change text: Set the front- and rear-panel controls as follows:

Add action:
- PLOTTER LOG-X/LIN-X switch to LIN-X

Paragraph 4.2.12

Add new Step v.: Place PLOTTER LOG-X/LIN-X switch (rear panel) in LOG-X position. Press PLOTTER RESET push button, then press PLOTTER SWEEP push button; observe that sweep rate on oscilloscope display proceeds at a slow rate (approximately 0.5 sec. per filter location) for the first 20 percent of the sweep, and then proceeds at the normal plotter rate for remainder of sweep. Place PLOTTER LOG-X/LIN-X switch in LIN-X position.

Renumber steps: Renumber existing Steps v., w., and x. to w., x., and y., respectively.

MODEL SD330 SPECTRASCOPE – REAL TIME ANALYZER

MANUAL CHANGES

Model: SD330
Unit Serial: As Applicable
Manual Edition: --

Each change listed below must be individually analyzed for applicability in accordance with "Action" directed relative to unit serial number and/or documentation affected.

Change #1

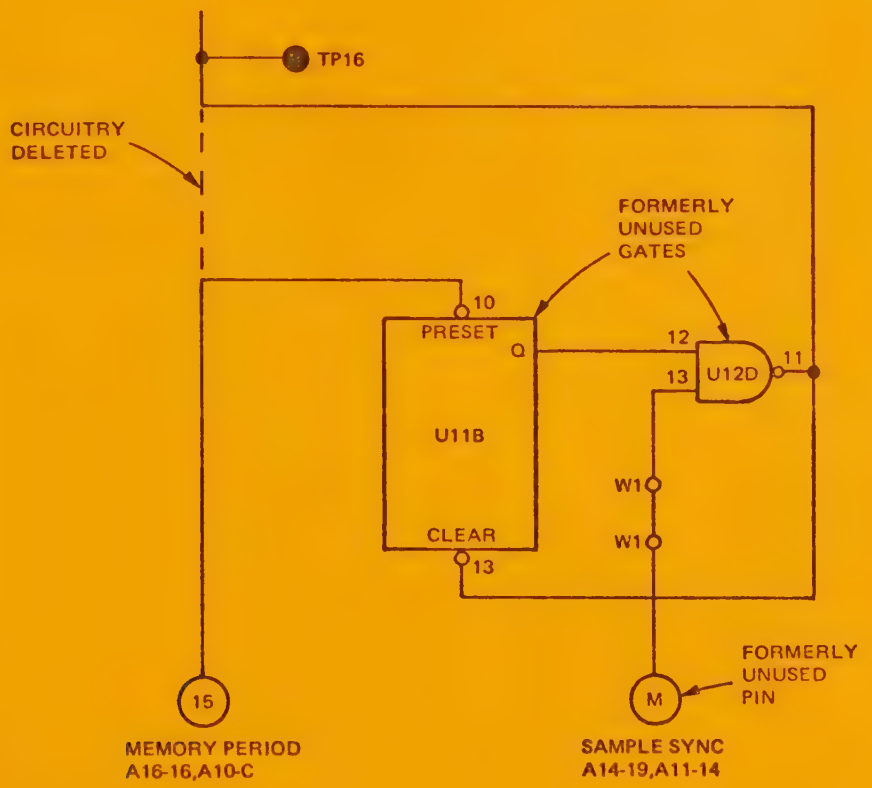
ECO-1436
(3-30-73)

Effectivity: S/N 011 and on.

Action:

1) Interconnecting Diagram, DWG. NO. 14301(H); Add wire connection between A14-19 and A17-M.

2) Schematic, DWG. NO. 14349(C), Circuit Card A17 (Averager Memory Assy. 14348-1); Add formerly unused gates of U11 and U12 connected as follows:



Change #2

ECO-1449
(3-27-73)

Effectivity: S/N 011 & on.

Action: Schematic, DWG. NO. 15466(E), Circuit Card A7 (Sweep Oscillator (VCO) Assy. 15464-1); Change R39 from 4.7k to 3.6k.

TABLE OF CONTENTS

Section — Page

I GENERAL INFORMATION

1.1 Introduction 1-1
1.2 Concept of Operation 1-1
1.3 Front-Panel Functional Description 1-1
1.4 Rear-Panel Functional Description 1-7
1.5 Specifications 1-9

II OPERATION

2.1 General 2-1
2.2 Types of Data Signals and Displays 2-1
2.2.1 Time Domain Versus Frequency Domain 2-1
2.2.2 Linear and Logarithmic Displays 2-1
2.3 Initial Powering Procedure 2-3
2.4 Operational Checkout Procedure 2-3
2.5 Preparation of External Display Devices 2-6
2.5.1 X-Y Recorder 2-6
2.5.2 Display Oscilloscope 2-8
2.5.3 3-D Display Control/Oscilloscope 2-8
2.6 Typical Applications and Associated Setup/Calibration Procedures 2-10
2.6.1 Analysis of Periodic Signal 2-10
2.6.2 Analysis of Rotating Machinery 2-11
2.6.3 Analysis of Acoustic Data 2-16
2.6.4 Analysis of Random Data (PSD Analysis) 2-17
2.6.5 Transient Recording 2-25
2.6.6 Transient Analysis 2-26
2.7 Auxiliary Functions Identification and Special Cable Requirements 2-28
2.8 General Reference Data 2-28

III CONCEPT AND THEORY OF OPERATION

3.1 Concept of Operation 3-1
3.2 Functional Block Diagram Description 3-1
3.2.1 Input Conditioning 3-1
3.2.2 Time Compression 3-1
3.2.3 Analyzer 3-2
3.2.4 Sweep Oscillator (VCO) 3-2
3.2.5 Master Clock 3-2
3.2.6 Digital Control 3-4
3.2.7 Display Oscilloscope 3-5
3.2.8 Averager 3-5
3.2.9 Power Supplies 3-7

TABLE OF CONTENTS (Continued)

Section — Page

IV CALIBRATION

4.1 General 4-1
4.2 Calibration Procedure 4-1
4.2.1 Preliminary Procedure 4-2
4.2.2 Low-Voltage Power Supply (A19) 4-2
4.2.3 High-Voltage Power Supply (A32) 4-2
4.2.4 Circuit Cards A1, A10, A11, A12 and A13 4-2
4.2.5 Circuit Card A8 4-4
4.2.6 Circuit Cards A2, A22, A23 4-4
4.2.7 Circuit Card A7 (VCO) 4-5
4.2.8 Circuit Card A6 4-5
4.2.9 Circuit Card A8 4-6
4.2.10 Circuit Card A31 and High-Voltage Power Supply A32 4-6
4.2.11 Circuit Card A2 Dither Adjustment 4-7
4.2.12 Final Checks 4-7
4.3 Parts Replacement 4-9

LIST OF TABLES

Number — Page

Table 1-1. Time Base Reference for SCOPE TIME Mode 1-4
Table 2-1. Typical Signals as Seen on the SD330 Spectrascope Display 2-2
Table 2-2. Decibel Table 2-3
Table 2-3. Frequencies for Identifying Vibration and Noise Sources 2-13
Table 2-4. Memory Parameters 2-18
Table 2-5. Input/Output Signal Data for AUXILIARY FUNCTIONS Connector, J17 2-28
Table 2-6. Engineering Terms and Interrelationships 2-28
Table 2-7. Time Duration of 1 Cycle 2-29
Table 2-8. Measurement of Displacement, Velocity, and Acceleration 2-29
Table 2-9. Representative Quantities in Air 2-29
Table 2-10. Acceleration Decibels and Velocity Decibels 2-29
Table 2-11. Acceleration Decibels (adB) Relative to g 2-29
Table 3-1. Comparison of Time Constants 3-7
Table 4-1. Test Equipment Required 4-1
Table 4-2. Special Replaceable Parts List 4-9

LIST OF ILLUSTRATIONS

Number		Page
Figure 1-1.	Concept of Operation	1-3
Figure 1-2.	Front Panel	1-3
Figure 1-3.	Rear Panel	1-9
Figure 2-1.	Calibration Signal	2-4
Figure 2-2.	Intensified Dots Set at Top of Each of 10 Frequency Markers	2-4
Figure 2-3.	Full-Scale Calibration Signal in MANUAL Mode	2-5
Figure 2-4.	Calibration Signal with Linear Amplitude Scale Set to Cover Full Graticule Height	2-5
Figure 2-5.	3-D Spectrum Data Display	2-9
Figure 2-6.	Instrument Setup for Obtaining 3-D Display	2-9
Figure 2-7.	Typical Plot of Unaveraged Spectra	2-12
Figure 2-8.	Typical Plot of Averaged Spectra	2-12
Figure 2-9.	Instrument Setup for Signature Ratio® Analysis	2-14
Figure 2-10.	Instrument Setup for RPM Tracking Analysis	2-15
Figure 2-11.	Typical Test Requirement for a Profile of Power Spectral Density	2-19
Figure 2-12.	Determination of Overall g rms Level	2-20
Figure 2-13.	Typical Test Requirement Showing a Flat PSD Spectrum Combined with a Periodic Signal	2-20
Figure 2-14.	Two Test Setups Used for Determining Effective (Noise) Bandwidth	2-24
Figure 2-15.	Setup for Viewing Memory Contents	2-25
Figure 2-16.	Oscilloscope Display Showing Approximate Zone of Truncation as Determined by Oscilloscope Trigger Delay	2-26
Figure 2-17.	Spectrum of 1 Cycle of a 500-Hz Signal	2-27
Figure 2-18.	Spectrum of 2 Cycles of a 500-Hz Signal	2-27
Figure 2-19.	Spectrum of 4 Cycles of a 500-Hz Signal	2-27
Figure 2-20.	Effect of Weighting Function	2-27
Figure 2-21.	Vibration Nomograph	2-30
Figure 3-1.	Simplified Block Diagram, Spectrascope	3-3
Figure 3-2.	Functional Block Diagram of Spectrascope (Sheet 1)	3-8
	(Sheet 2)	3-9
Figure 4-1.	Location of Major Assemblies	4-3

LIST OF DRAWINGS

(Located at Rear of Manual)

Circuit Card Ref. Desig.	Drawing No.	Title
A1	10044800	Clock, Assy 10045000
A2	14302	A-D Converter, Assy 14304-1
A3, A4	14308	Memory, Assy 14310-1
A5	14313	High-Speed D-A Converter, Assy 14312-1
A6	14319	Scan Mixer, Assy 14318-1
A7	15466	Sweep Oscillator, Assy 15464-1
A8	14320	Detector and Output Amplifier, Assy 14322-1
A10	14331	Display Control/Marker Generator, Assy 14330-1
A11	14326	Counter Control, Assy 14328-1
A12	14332	Counter, Assy 14334-1
A13	14337	BCD Ladder, Assy 14336-1
A14	14338	Averager A-D Converter, Assy 14340-1
A15	14343	Averager Timing, Assy 14342-1
A16	14344	Averager Divide Select, Assy 14346-1
A17	14349	Averager Memory, Assy 14348-1
A18	14350	Averager D-A Converter, Assy 14352-1
A19	14355	Low-Voltage Power Supply, Assy 14354-1
A20	14415	Mother Board (Left), Assy 14414-1
A21	14416	Mother Board (Right), Assy 14418-1
A22	14360	Input Range (Coarse), Assy 14362-1
A23	14365	Input Range (Fine), Assy 14364-1
A24	14384	Input Assembly, Assy 14816-1
A25	14366	Operate/Calibrate, Assy 14368-1
A26	10032100	Output Gain/Y Display, Assy 10032300
A27	14372	Number of Averages, Assy 14374-1
A28	14377	Averages Control, Assy 14376-1
A29	14378	Display Functions, Assy 14380-1
A30	14383	Memory/Markers, Assy 14382-1
A31	14359	Horizontal & Vertical Amplifiers, Assy 14358-1
A32	14813	High-Voltage Power Supply, Assy 14812-1
	14301	Interconnecting Diagram

PREFACE

RECEIVING INSPECTION PROCEDURE

The Model SD330 Spectrascope–Real Time Analyzer is shipped fully assembled, packed in a polystyrene case designed to protect it against all normal shipping hazards. Immediately upon receipt, inspect the exterior of the shipping case and note any visible damage. Keep all forms and invoices attached to the shipping case. Remove the instrument from the shipping case and test its functional operation in accordance with Section II of this manual. If shipping damage is apparent, file a claim with the carrier's claims agent and send a copy to Spectral Dynamics Corporation. Be sure to include the instrument name, model number, and serial number on all correspondence. Spectral Dynamics Corporation will advise the buyer what should be done; arrangements for repair or replacement will be made as applicable.

WARRANTY POLICY

All Spectral Dynamics products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain components listed in some of the operating manuals, for the specified period. We will repair or replace products which prove to be defective during the warranty period, providing the failure or damage has not been caused by misuse or abnormal operating conditions. Fuses and lamps are specifically excluded from warranty. If the malfunction or a portion thereof is determined by Spectral Dynamics Corporation to have been caused by misuse or abnormal conditions of operation, an estimate of cost to repair will be submitted to the purchaser for approval before beginning any repair work.

Liability under this warranty is limited to servicing and adjusting the instrument returned to the factory, with transportation charges prepaid by the purchaser. No other warranty is expressed or implied. We are not liable for consequential damages.

If any malfunction develops, notify Spectral Dynamics Corporation or its representative in your area, giving details of the problem, and the name, model and serial number of the equipment. Upon receipt of this information, service data or shipping instructions will be provided.

RETURN SHIPMENT PROCEDURE

On receipt of shipping instructions, forward the instrument prepaid via air freight to the factory or authorized repair station indicated on the instructions. Replace the instrument in its original shipping case, or surround with two to three inches of shock absorbing material and then pack it in a heavy-weight cardboard box, wooden box, or other strong container.

SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

The Model SD330 Spectrascope–Real Time Analyzer combines three basic instruments (analyzer, averager, and display oscilloscope) in a single unit to provide a complete audio data analyzer. With input frequency ranges up to 20 kHz and resolution bandwidths down to 0.15 Hz, the SD330 achieves speed increases of "orders of magnitude" over standard audio analyzers.

The Model SD330 is highly flexible in operator-selected modes of operation. For example, in the SCOPE TIME mode the input data waveforms can be displayed on the front-panel oscilloscope to allow observation of gross data values, bias voltages, possible limiting, etc. Then, by switching to SCOPE SPECT mode, the narrow-band real time spectrum of the input data is selected for front-panel display and rear-panel outputing to external recording and/or display equipment. If the input signals are noisy, or if their spectrum value fluctuates with time, successive spectra can be averaged in groups of 2, 4, 8, 16, etc., (binary progression) up to 512. In addition, an exponential averaging mode can be selected; that is, after the selected number of averages has been reached, a running average will be continued until a "stop" command is issued.

A peak-hold mode allows detection and storage of the peak values for all filter locations. When selected, the peak-hold mode continues until a "stop" command is given. Also, through use of a transient capture mode, a segment of the input data can be captured and stored in memory for examination.

The X (frequency) and Y (spectrum) outputs for external monitoring or X-Y recording are available at a rear-panel connector. Also available at an adjacent connector are parallel binary words proportional to spectrum data.

1.2 CONCEPT OF OPERATION

The Model SD330 employs time compression techniques to achieve minimum analysis time for the frequency-tuned bandpass filter to convert the input signal from the time domain to the frequency domain. (See Figure 1-1.) Following compression, the input signal is frequency analyzed using 250 synthesized filter locations that are tuned by a built-in sweep generator.

When the averaging mode is selected, successive analyzed spectra (in digital form) are summed in a recirculating memory. The output of the memory is loaded into a register where it is divided by binary steps and ultimately by "N," the number of averages selected. The resultant output is the average spectrum. Note that because the divisor is a function of the number of averages selected, an exact accounting of statistical averaging time is always available. If exponential averaging is selected, after the preselected number of averages has been completed averaging is continued with each subsequent spectrum sweep using a recursion process. That is, as each new spectrum is developed, the difference between the new spectrum and the existing average is divided by "N," and the result is then added to the "existing average" to develop the new average value. Mathematically the recursion formula is as follows:

$$A_{i+1} = Ai + \frac{X_{i+1} - Ai}{N}$$

Where i → Number of averages > N
A → Average
X → New data

1.3 FRONT-PANEL FUNCTIONAL DESCRIPTION

The following paragraphs briefly describe the functions of each of the front-panel controls and indicators, illustrated in Figure 1-2.

POWER Push Button Switch/Indicator

Pressed to turn instrument power on or off; lighted when power is on.

SIGNAL INPUT Connector

Accepts signal to be analyzed; is connected in parallel with J2, SIGNAL INPUT connector on rear of chassis.

AC/DC Input Selector

Selects either a direct-coupled (DC) input circuit to provide flat frequency response for low frequency signals, or an a-c coupling (AC) circuit to block a d-c level that might be present on the signal applied to the SIGNAL INPUT connector. In AC position, the lower cut-off frequency is 0.4 Hz.

INPUT RANGE/CAL Push Buttons

Coarse and fine range switches permit 0 to 50 dB attenuation of the input signal in 1 dB steps. The coarse range switches provide five input ranges calibrated in Vrms (.1, .316, 1, 3.16, and 10 Vrms) and the corresponding dB ranges (0, 10, 20, 30, and 40 dB). The five coarse range push buttons are mechanically interlocked so that only one can be depressed at a time.

The four fine range push buttons are "push-push" type, not mechanically interlocked, and provide 0 to 10 dB attenuation in 1 dB steps to give complete coverage between the 10 dB increments of the coarse range switches. The total fine range attenuation equals the sum of the values of the fine range push buttons depressed. In summary, the signal input range can be selected from 0.1 Vrms to 31.6 Vrms in 1 dB steps for full scale output.

INPUT Meter

Continuously displays the peak value of the normalized and band-limited input signal. The meter scale is linearly divided into 10 increments, from zero to full scale. To cover the wide frequency range of the analyzer, the peak-holding time constants of the meter circuit are automatically varied as a function of the selected analysis range.

Input OVERLOAD Indicator

Lights while the input signal is exceeding full scale of range selected. When lighted, distortion could be present on the display.

ANALYSIS RANGE Selector

Selects analyzer upper frequency range, 25, 100, 200, 500, 1K, 2K, 5K, 10K, or 20K UPPER LIMIT (Hz), associated resolution bandwidth, .15, .6, 1.2, 3, 6, 12, 30, 60, or 120 BANDWIDTH (Hz) respectively, and MEMORY PERIOD (SEC) for each range. The BANDWIDTH (Hz) markings also denote the lowest useful frequency of each range. For each range position, a low-pass filter (with cutoff at 1.1 times the upper limit frequency) is inserted in the signal path, and the sampling rate (three times the upper limit frequency) is automatically selected.

OPER and CAL Mode Selector Push Buttons

OPER Push Button

Depressed to select the normal operating mode. When depressed, with the SCOPE SPECT mode also selected, the spectrum of the input signal is available for display on the Spectrascope, and is also available at the rear-panel output connectors in log or linear d-c form for application to an external oscilloscope or recorder. The output is in accordance with the selected range, mode, markers, etc. The OPER push button is mechanically interlocked with the CAL push buttons (except LIN ZERO which is a momentary switch). When depressed, with the SCOPE TIME mode selected, the normalized but unfiltered input signal is displayed in time domain and sweep time is a function of ANALYSIS RANGE selector position. For operation in AVG modes, the OPER push button also must be depressed.

CAL SPECT Push Button

When depressed, with SCOPE SPECT mode also selected, an internally-generated square wave signal at a frequency 3/10 the upper limit of the selected analysis range replaces the input signal. This provides calibrated spectrum lines at 30 percent and 90 percent of the selected analysis range. The calibration signal (0 to 5 Vdc full scale) is also available at the SPECT-Y rear-panel output connectors. Amplitude of this signal is controlled by the push buttons of the INPUT RANGE/CAL coarse and fine attenuators. For full-scale amplitude, only the .1 Vrms/0 dB push button is depressed. In SCOPE TIME mode with the CAL SPECT push button also depressed, internally-generated square waves are displayed with time axis a function of the ANALYSIS RANGE selector position.

CAL FREQ Push Button

When depressed, with the INPUT RANGE/CAL .1 Vrms/0 dB push button also depressed, a full scale, 5V d-c output representing the upper limit frequency of the analysis range is provided at the LIN-X and LOG-X output connectors on the rear of the chassis. Amplitude of this calibration signal is controlled by the push buttons of the INPUT RANGE/CAL coarse attenuator as follows:

Push Button Depressed	LIN-X and LOG-X Output
.1 Vrms/0 dB	Full scale
1 Vrms/20 dB	1 decade down
10 Vrms/40 dB	2 decades down

CAL LIN ZERO Push Buttons

When depressed, with the CAL FREQ push button also depressed, a zero reference for frequency-axis calibration is available at the LIN-X output connector. When depressed, with the CAL SPECT push button also depressed, a zero reference is available for calibration at SPECT-Y output connector. This switch is a momentary type, not mechanically interlocked with other push buttons. However, while this switch is pressed, the zero-reference calibration signal overrides any other calibration signal that may be present.

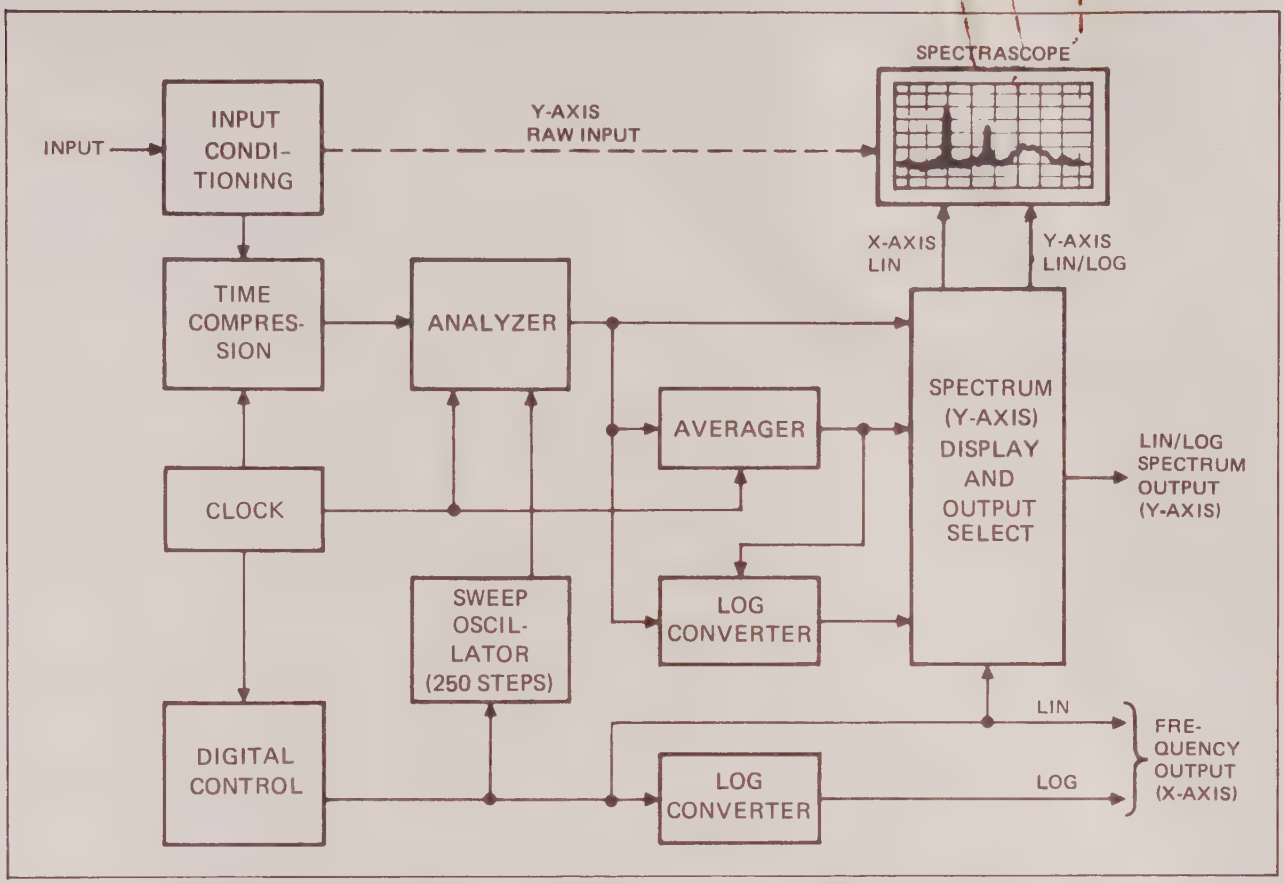


Figure 1-1. Concept of Operation

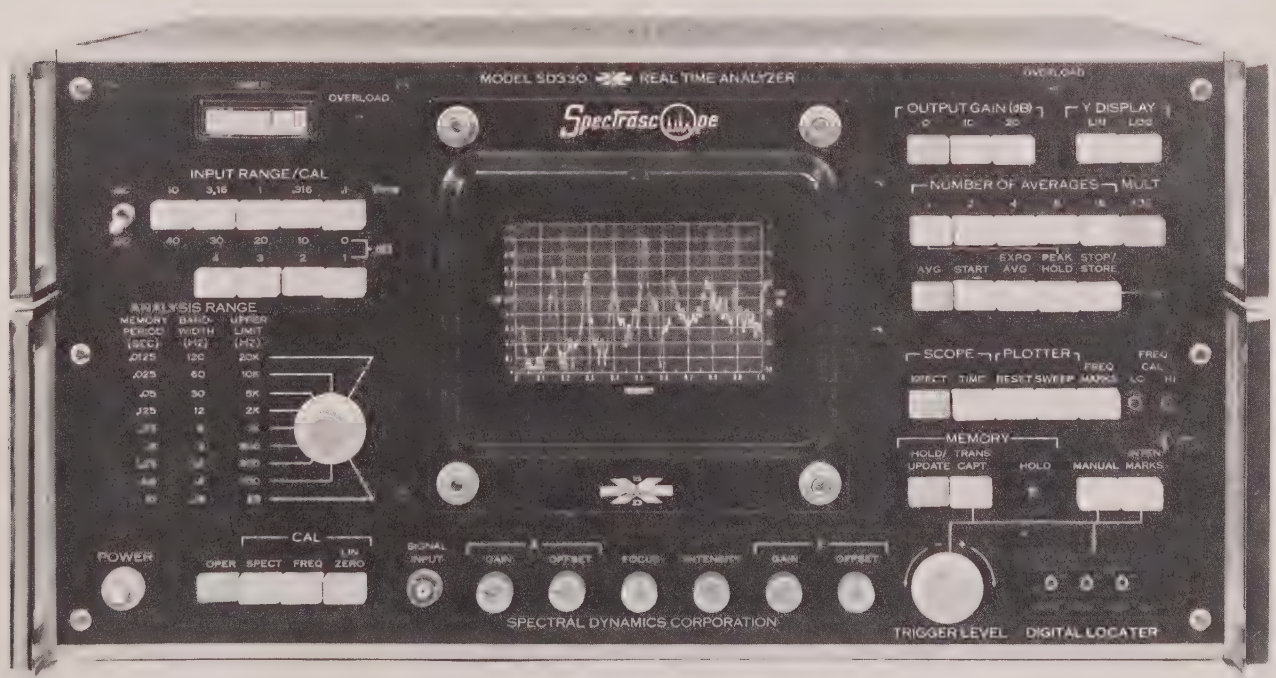


Figure 1-2. Front Panel

Y DISPLAY LIN/LOG Push Buttons

These mechanically interlocking push buttons determine type of Y-axis display (linear or log) on the Spectrascope as well as type of signal available at the rear-panel SPECT-Y output connectors. Full-scale linear and log outputs are 5 Vdc.

OUTPUT GAIN (dB) Push Buttons

Provide additional post-filter gain as follows: 0 dB (X1 or unity gain) which is the selection for normal operation when analyzing periodic input signals; 10 dB (X3.16) or 20 dB (X10) can be selected as required for a suitable output display.

Output OVERLOAD Indicator

Lights while the analyzer output signal is exceeding its linear range. Note that although the input OVERLOAD indicator may not be lit also, the output spectrum peak could exceed its linear range, thus requiring more attenuation of the input signal with the INPUT RANGE/CAL push buttons.

SCOPE SPECT/TIME Mode Push Buttons

Select type of display (frequency or time domain) to be presented on the Spectrascope. These push buttons are mechanically interlocked with each other and with the PLOTTER RESET/SWEEP push buttons.

SCOPE SPECT Push Button

When depressed, with the OPER mode also selected, the Spectrascope display is the real time analysis of the input signal data in frequency domain, 250 line filters, presented every 50 milliseconds. (Real time up to 5-kHz analysis range.)

SCOPE TIME Push Button

When depressed, with the OPER mode also selected, the Spectrascope display is the raw input signal data in the time domain. (The signal is normalized but not band limited.) In this mode, the sweep time is a function of the ANALYSIS RANGE switch setting. To facilitate calibration in this mode, square wave signals are available when the CAL SPECT push button is depressed. Periods of these signals are listed in the second column of Table 1-1. It is emphasized that full-scale calibration amplitudes are available only with the INPUT RANGE/CAL .1 Vrms/dB push button depressed. The third column of Table 1-1 gives the time base that exists per graticule division if the SD330 is switched to the SCOPE TIME mode after being calibrated for a spectrum display in SCOPE SPECT mode.

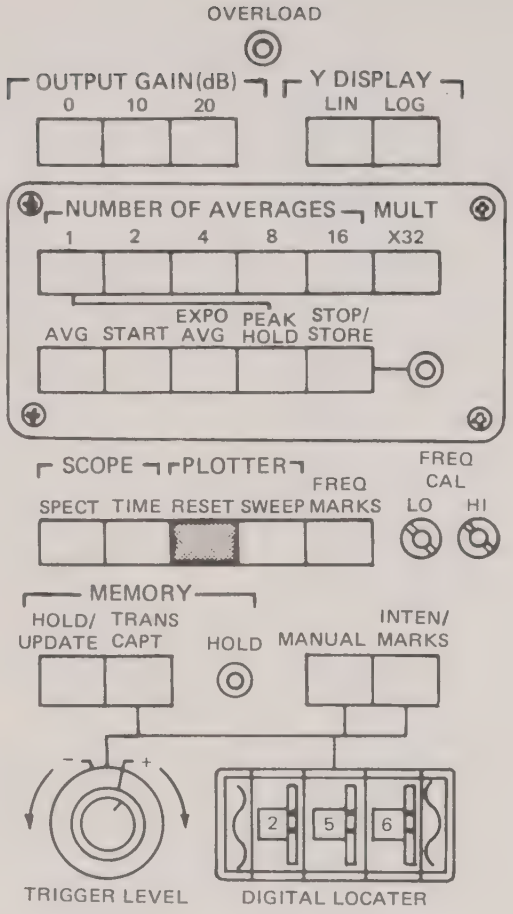


Table 1-1. Time Base Reference for SCOPE TIME Mode

Analysis Range	Period of Square Wave Calibration Signal	Sweep Period Per Graticule Division
20 kHz	200 μs	166.7 μs
10 kHz	400 μs	333.3 μs
5 kHz	800 μs	666.7 μs
2 kHz	2 ms	1.67 ms
1 kHz	4 ms	3.33 ms
500 Hz	8 ms	6.67 ms
200 Hz	20 ms	16.67 ms
100 Hz	40 ms	33.33 ms
25 Hz	160 ms	133.3 ms

PLOTTER RESET/SWEEP Mode Selector Push Buttons

Pressed to select PLOTTER mode, and to reset or initiate a PLOTTER mode sweep. These push buttons are mechanically interlocked with each other and with the SCOPE SPECT/TIME push buttons.

PLOTTER RESET Push Button
Depressed in PLOTTER mode to reset the recorder X-axis to zero.

PLOTTER SWEEP Push Button
Depressed to initiate a plotter sweep output. The basic time for one complete sweep is approximately 25 seconds. However, in PLOTTER SWEEP mode, sweep rate feedback is automatically activated; that is, sweep speed is a function of the rate of change of the amplitude variations in the Y-axis output. If a large amplitude variation occurs in the Y-axis, the sweep is automatically slowed to allow the plotter to respond.

CAUTION

When recording averaged data, start sweep only after STOP/STORE indicator lights continuously. If flashing, press STOP/STORE push button. After starting a sweep, allow to complete before selecting any other mode of operation. If this is not done, the data stored in the averager memory will not be synchronized with the proper filter locations. The RESET push button is provided in red as a reminder to observe sweep completion.

At the end of a sweep, the X-axis output remains at full scale until the PLOTTER RESET, SCOPE SPECT or SCOPE TIME push button is pressed.

FREQ MARKS Selector Push Button
When depressed, 10 equally-spaced frequency markers are applied to the output spectrum, approximately 20 dB below full scale. Note that when OUTPUT GAIN (dB) 20 is selected, the markers are automatically attenuated to prevent overloading. To remove the frequency markers, the push-push type FREQ MARKS push button must be released by pressing again.

MANUAL/INTEN MARKS Selector Push Buttons

MANUAL Push Button
When depressed, the analyzer operates as a tunable filter, the center frequency of which is manually selected by the 3-digit, DIGITAL LOCATER thumbswitch. In this mode, the spectrum of the selected analysis range can be tuned to any one of 999 frequency increments across the X-axis. The MANUAL mode should not be used in conjunction with averaged spectra.

INTEN MARKS Push Button
When depressed, an intensity marker (bright spot on the oscilloscope) is provided over a point of the X-axis as selected by the DIGITAL LOCATER thumbswitch. (This feature is available only in the SCOPE SPECT mode.) Note that because the DIGITAL LOCATER thumbswitch increments from 1 to 999 in single-digit steps, and there are 250 filter locations, an intensity marker will stay over a point through 4-digits change of the switch.

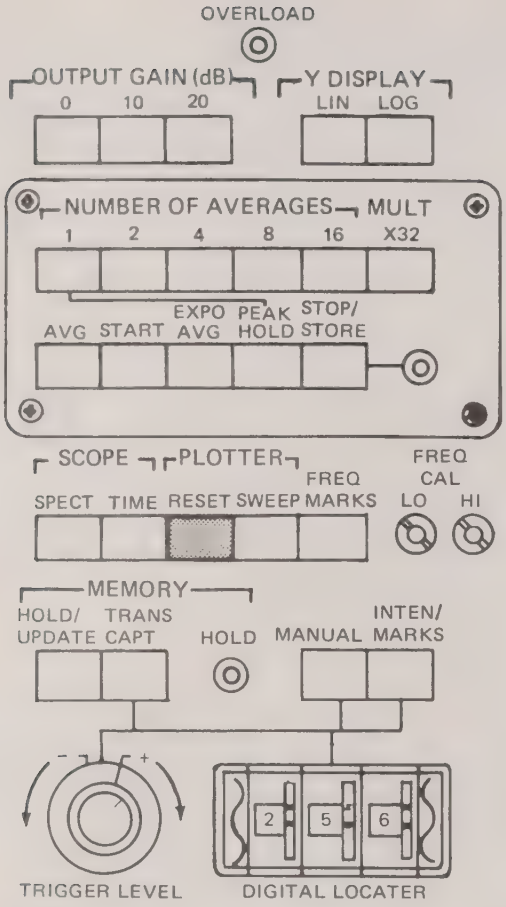
For X-axis calibration with the frequency markers applied, the DIGITAL LOCATER is set to 000 and the INTEN MARKS push button is depressed. In this condition, 10 intensity markers, one on top of each frequency marker, will appear on the Spectrascope. If necessary, the markers can be aligned using the FREQ CAL LO/HI calibration adjusters described below. The intensity marks can be used in conjunction with both averaged and unaveraged spectra.

FREQ CAL LO/HI Calibration Adjusters
Used to calibrate the X-axis; that is, align the frequency markers and intensity markers described above. The LO adjuster sets the starting point of the sweep; the HI adjuster determines the spread and distance between the markers.

MEMORY HOLD/UPDATE Push Button and HOLD Indicator
This push-push type button must be depressed to initiate HOLD mode, then pressed again to release for the UPDATE mode. In UPDATE mode, the input signal data is continuously entered into memory at the selected sampling rate; the HOLD indicator is not lit. In HOLD mode, the memory contents are continuously circulated and displayed; no new data is entered into memory and the HOLD indicator is lit.

MEMORY TRANS CAPT Push Button
When this momentary type switch is pressed, the analyzer goes into UPDATE mode (described above) to await a transient capture trigger. When triggered, the number of samples selected by the DIGITAL LOCATER thumbswitch (up to 750) are loaded into memory. The analyzer then goes into HOLD mode. The level at which the loading of samples begins is set by the TRIGGER LEVEL control.

TRIGGER LEVEL Control
Used in SCOPE TIME, MEMORY TRANS CAPT, and CAL SPECT modes to set the level (+ or –) at which the X-axis sweep will be triggered by the input signal (or by the CAL signal in CAL mode).



DIGITAL LOCATER Thumbswitch

Used with the MANUAL, INTEN MARKS, and MEMORY TRANS CAPT push buttons described above.

NUMBER OF AVERAGES and MULT X32 Push Buttons

Push buttons 1, 2, 4, 8, and 16 are mechanically interlocked. The button depressed (with the MULT X32 button out) determines the number of spectra to be averaged in a normal averaging operation (initiated by the START push button).

The MULT X32 push button is the push-push type. When depressed, the value of the selected NUMBER OF AVERAGES push button is multiplied by 32, thus providing averages of 32, 64, 128, 256, or 512 spectra.

AVG, START, EXPO AVG, PEAK HOLD, STOP/STORE Push Buttons

The AVG push button is a separate push-push type, and must be depressed before any of the averager modes can be selected. The AVG push button also can be used to select averaged or unaveraged data for viewing on the Spectrascope or for external recording, but only after an averaging process has been completed and the averaged data is being held in the averager memory.

The START, EXPO AVG, PEAK HOLD, and STOP/STORE push buttons are mechanically interlocked; each selects a particular mode of operation as follows:

START Push Button

Pressed to initiate a normal averaging mode. The memory is cleared (erased), non-redundant spectra representing input data are averaged until the selected number of averages is completed, the average spectrum is held (stored) in the averager memory, and the STOP/STORE indicator lights.

The total averaging time in the START mode is the product of the number of averages selected and the memory period of the selected analysis range. For example, if 16 averages are selected on the 1-kHz range (0.25-sec memory period), the total averaging time will be 4 sec. This information is valid for all but the 10-kHz and 20-kHz analysis ranges. To calculate the total averaging time in either of these two ranges, a memory period of 0.05 sec must be used. Therefore, the total averaging time on either of these ranges with 16 averages selected will be 16 x 0.05 sec = 0.8 sec.

When averaging is initiated by the START button, the averaging process is automatically stopped after the selected number of averages has been averaged, and the STOP/STORE indicator lights continuously. Pressing the STOP/STORE push button after an averaging mode has been initiated with the START push button will stop the process, but the results will not be valid if the process is stopped before the indicator has come on.

EXPO AVG Push Button

Pressed to extend the averaging process after the STOP/STORE indicator lights at the end of a normal averaging run initiated with the START button. When the EXPO AVG button is pressed, the STOP/STORE indicator flashes and averaging continues until the STOP/STORE button is pressed. The last completed average is then held in memory and the STOP/STORE indicator is continuously lit.

In EXPO AVG mode, the difference between the value of each subsequent new spectrum and the existing average spectrum being held in memory is divided by "N" (the number of averages selected). The result is

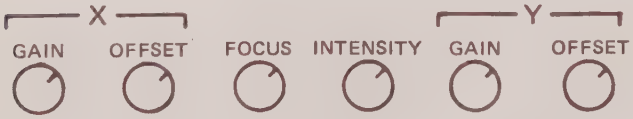
added to the "existing" average spectrum to obtain the new average. This recursion process makes the averaging equivalent to exponential averaging as determined by R-C averaging in a continuous system. The "time constant" is proportional to the product of the selected No. of averages and the memory period of the selected analysis range. It is emphasized however that a memory period of 0.05 sec must be used when calculating the "time constant" in either the 10-kHz or 20-kHz analysis range. (The EXPO AVG mode is described in greater detail in Section III.)

PEAK HOLD Push Button
When the PEAK HOLD push button is initially pressed, the averager memory is erased and the next complete spectrum from the analyzer is entered. Upon receipt of each subsequent spectrum, each filter location (250 positions) is updated, but only in a positive direction. That is, if the data value for any particular location is equal to or less than that of the previously held data, no change occurs in that location. Only an increase in value causes an update to the new higher value. During PEAK HOLD mode, the STOP/STORE indicator flashes. This mode is terminated by pressing the STOP/STORE push button. In the PEAK HOLD mode, regardless of number of averages selected, the display will be updated every memory period.

STOP/STORE Push Button
Pressed to terminate either EXPO AVG or PEAK HOLD mode. (If pressed during averaging initiated by the START button, the results will not be valid.)

STOP/STORE Indicator
Lights continuously at the end of an averaging run to indicate that the average spectrum is being held in memory. Indicator flashes when either EXPO AVG or PEAK HOLD mode is in process.

SPECTRASCOPE Controls



X-GAIN
Varies the gain of the X amplifier; provides adjustment from zero to approximately 2.5 times full scale.

X-OFFSET
Positions display lines horizontally.

Y-GAIN
Varies the gain of the Y amplifier; provides adjustment from 1/2 full scale to approximately 3 times full scale.

Y-OFFSET
Positions display lines vertically.

INTENSITY
Adjusts the brightness of the display; turn clockwise for brighter display.

FOCUS
Focuses the trace lines for displaying sharpest details.

1.4 REAR-PANEL FUNCTIONAL DESCRIPTION

The following paragraphs briefly describe the function of each of the rear-panel connectors, switches, and fuse holders, illustrated in Figure 1-3.

SIGNAL INPUT Connector (J2)
Accepts data signals to be analyzed; is connected in parallel with the front-panel SIGNAL INPUT connector; is affected by setting of the AC/DC switch on the front panel. (Refer to description of front panel in Paragraph 1.3 for functions of the SIGNAL INPUT connector and the AC/DC input selector.)

SCOPE Outputs

SPECT-Y (J3)
Provides a 0V to 5V output proportional to the sampled signal amplitude of the synthesized filter location. The output is in either linear or log form as determined by the front-panel Y DISPLAY push buttons. In PLOTTER SWEEP mode, the output of J3 is the same as that at the PLOTTER SPECT-Y connector, J6.

LIN-X (J4)
Provides a 0V to 5V d-c sweep output every 50 milliseconds in OPER-SCOPE SPECT mode. In OPER-SCOPE TIME mode, the sweep time is a function of the ANALYSIS RANGE switch setting. In CAL FREQ mode, fixed d-c voltages are available as selected by the five, coarse INPUT RANGE/CAL push buttons. In PLOTTER SWEEP mode, the output of J4 is the same as that at the PLOTTER LIN-X connector, J7.

LOG-X (J5)
Provides a 0V to 5V d-c output (100 mV/dB) that is proportional to the log of the LIN-X J4 output. In PLOTTER SWEEP mode, the output of J5 is the same as that at the PLOTTER LOG-X connector, J8.

PLOTTER Outputs

NOTE

As previously described, the SCOPE outputs are the same as the correspondingly marked PLOTTER outputs when operating in the PLOTTER SWEEP mode. However, when operating in any of the SCOPE modes, there are no outputs available at the PLOTTER output connectors. Therefore, an X-Y recorder (plotter) can be permanently connected to the PLOTTER output connectors if desired.

SPECT-Y (J6)
Provides a 0V to 5V output that is proportional to the sampled signal amplitude of the synthesized filter location. The output is in either linear or log form as determined by the front-panel Y DISPLAY push buttons. Output is available only in PLOTTER SWEEP mode.

LIN-X (J7)
Provides a 0V to 5V sweep output, made up of 1000 incremental voltage steps that determine position of the synthesized filter locations. Output is available only in PLOTTER SWEEP mode.

With low level or no spectrum data output, a normal sweep is outputed in 25 seconds; however, an internal "sweep-rate feedback" circuit causes the sweep to be slowed if large variations occur in the amplitude of the SPECT-Y output.

LOG-X (J8)
Provides a 0V to 5V sweep output that is proportional to the log of the LIN-X (J7) output. Output is available only in PLOTTER SWEEP mode.

RETRACE BLANKING (J9)
Provides 0V during a sweep, and a 3.5V d-c level from the end of one sweep to the beginning of the next sweep.

SWEEP TRIGGER (J11)
Provides a transition from 3.5V to 0V that is synchronized with the start of each sweep; transition is back to 3.5V at end of sweep.

MEMORY Control Input and Outputs

HOLD CONTROL INPUT (J12)
Application of 3.5V (nominal) will place the memory in HOLD mode, described in Paragraph 1.3 for the front-panel MEMORY HOLD/UPDATE push button and HOLD indicator.

SYNC (J13)
Provides a 3.5V pulse of approximately 8-microseconds duration every time the memory recirculates.

OUTPUT (J14)
Provides a speeded-up replica of the input signal stored in memory. This signal also contains the internal markers, if selected.

PEN LIFT (J15, J16)
Provides a normally-open set of contacts. During a plotter sweep the contacts are closed and are then automatically opened during RESET. Circuit is isolated from ground. Before using, observe the following CAUTION.

CAUTION

To prevent permanent damage to the pen lift relay contacts in the SD330, be sure that a diode is installed across the pen lift solenoid coil in the recorder being used.

AUXILIARY FUNCTION (J17)
Provides interconnection points for connecting the SD330 with ancillary equipment such as the Model SD306 Signature Ratio® Adapter, or the Model SD307 Low Frequency Translator. Refer to Paragraph 2.7 of Section II for identification of auxiliary functions.

Fuse Holders F1/F2
Fuse holder F1 contains a type 3AG, 10A fuse. A SLO-BLO type fuse **must not** be used for F1.

Fuse holder F2 contains a type 3AG, SLO-BLO fuse; 2½A for 115V operation, or 1¼A for 230V operation.

115/230 Switch
Facilitates changeover of primary power input circuit for either 115V or 230V operation. Proper input voltage to be applied shows in window: screwdriver blade slot is up for 115V operation and down for 230V operation.

POWER Connector (J19)
Accepts 3-wire plug and cable (supplied) for applying 115/230 Vac, 50–400 Hz primary input power. Center terminal is chassis ground. Uses Belden No. 17258-S cable.

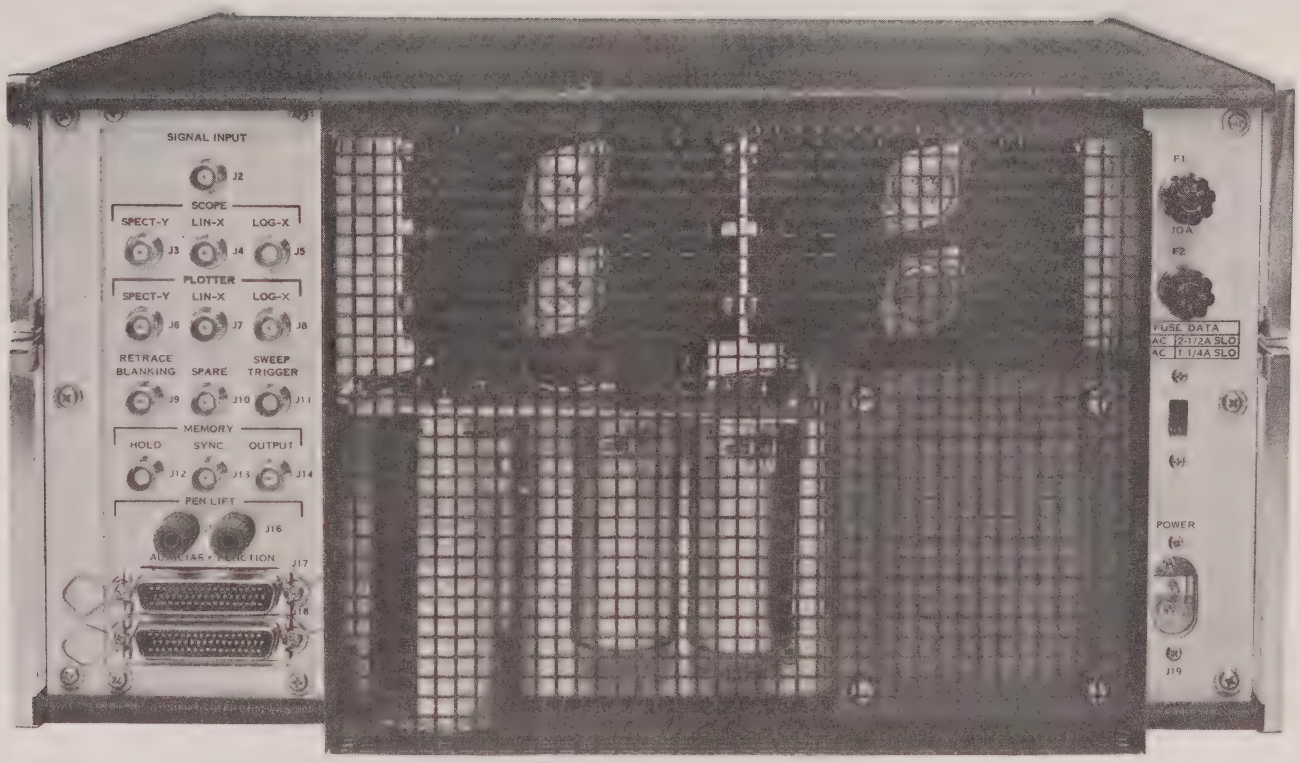


Figure 1-3. Rear Panel

1.5 SPECIFICATIONS

INPUTS

Frequency Range

. . . 0.15 Hz to 20,000 Hz in nine selectable ranges as follows:

Upper Frequency Limit	3 dB BW (Hz)	Memory Period (seconds)
20 kHz	120	0.0125
10 kHz	60	0.025
5 kHz	30	0.05
2 kHz	12	0.125
1 kHz	6	0.25
500 Hz	3	0.5
200 Hz	1.2	1.25
100 Hz	0.6	2.5
25 Hz	0.15	10.0

Frequency Response

. . . ±1 dB over entire frequency range.

Sensitivity (for full-scale output)

. . . 0.1 Vrms to 31.6 Vrms adjustable in 1 dB steps.

Coupling

. . . Selectable AC/DC.

Level Indication

. . . Input monitor meter with overload light.

Impedance

. . . 100 kΩ

Dynamic Range (full scale to minimum discernible signal)

. . . 48 dB.

Noise Level

. . . 50 dB below full scale.

Frequency Markers

. . . Ten equally spaced frequency markers, switch selectable.

OUTPUTS

Internal Scope Monitor

X Axis

. . . Linear frequency or time.

Y Axis

. . . Linear or log spectrum or input signal.

Memory Contents
. . . 300 mV p-p (nominal) full scale signal displaying the analog replica of the time-compressed signal stored in memory.

Impedance
. . . Spectrum and frequency outputs, less than 250 Ω.

Spectrum (Y axis)

Linear
. . . 0 to 5V (nominal) smoothed output.

Log
. . . 0 to 5V (nominal) log smoothed spectrum output (100 mV/dB).

Linearity of Spectrum Output
. . . ±0.5% of full scale or ±1 dB, whichever is greater.

Frequency (X axis)

Linear
. . . 0 to 5V (nominal) smoothed ramp.

Log
. . . 0 to 5V (nominal) full scale smoothed log ramp.

Sweep Trigger
. . . A TTL-compatible transition is furnished to synchronize with the start of the sweep.

ENSEMBLE AVERAGING

AVG Mode
. . . Selects averaging mode and transfers spectrum display to averager memory.

START Mode
. . . Performs selected number of averages on a non-redundant basis. Averaging stops when the selected number of averages has been reached. The averaging process is continuously normalized every binary step.

EXPO (exponential) AVG Mode
. . Takes a selected number of averages and once the number of averages has been reached, a flashing light comes on and the exponential averaging continues until an averaging STOP command is given.

PEAK HOLD Mode
The highest level in each of the 250 filter locations is retained until exceeded. Peak values can be held or erased using front panel controls.

STOP Mode
. . . Averaging process is halted (normally used in conjunction with EXPO AVG or PEAK HOLD mode). Indicator continuously lit.

No. of Averages
. . . 1 through 512, selectable in binary sequence.

MISCELLANEOUS

Transient Capture Operation
. . . Number of words selected by thumbwheel switch is loaded into memory when signal input exceeds threshold set by front-panel TRIGGER LEVEL control. Data is then automatically stored in memory and the analyzer reverts to HOLD mode.

Intensity Markers
. . . Variable-frequency intensity marker is superimposed on oscilloscope display of either real time or averaged spectrum data. Adjustable in resolution element increments of 1.

Manual
. . . Analyzer is tuned to selected frequency increment. Tuning adjusted by front-panel three-digit thumbwheel selector. Not used in AVG modes.

Frequency Linearity
. . . ±0.4% from best straight line of full analysis range.

Internal Calibration
. . . Calibrates entire analyzer from signal input to d-c outputs.

Y Axis
. . . Log: Full scale to –50 dB in selectable 1 and 10 dB steps.
Lin: Full scale and LIN ZERO selectable.

X Axis
. . . Log: Full scale to –2 decades in selectable decade steps.
Lin: Full scale and LIN ZERO selectable.

Oscilloscope Controls
. . . X axis GAIN and OFFSET.
Y axis GAIN and OFFSET.
FOCUS.
INTENSITY.

Output Gain (prior to averaging)
. . . Selectable 0 dB, 10 dB, 20 dB.

Output Overload

. . . Output overload indicator light.

Display Rates

Oscilloscope

. . . 50 milliseconds per sweep (20 scans per second).

X-Y Recorder

. . . Display completed in nominal 25 seconds. Plotter rate control is furnished for automatic slowdown during recording of data peaks. Automatically selected to respond to linear or log amplitude display. 1000 frequency axis points are furnished for optimum smoothing.

Power

. . . 105–125/210–250 Vac (switch selectable), 50–400 Hz.

Fuses

. . . 1 type 3AG, 10A.
1 type 3AG, SLO-BLO; 2½A for 115V operation, or 1¼A for 230V operation.

Dimensions

Height	22,23 cm (8.75")
Width (w/furnished rack-adapter ears)	48,3 cm (19")
Depth	48,6 cm (20")
Weight	20,7 kg (approx. 48 lb)

SECTION II

OPERATION

2.1 GENERAL

This section contains applications data for the Spectrascope together with procedures for determining operational characteristics of the instrument and procedures for calibrating the built-in display, an external display, and recording devices. Included data consists of a review of the types of data signals and displays (Paragraph 2.2) and reference information of a general nature at the end of the Section.

2.2 TYPES OF DATA SIGNALS AND DISPLAYS

The Model SD330 Spectrascope–Real Time Analyzer produces an output proportional to the magnitudes of the Fourier components of a signal over selected frequency ranges. The built-in oscilloscope provides for time domain display and frequency domain display of linear frequency along the horizontal (X) axis versus linear or logarithmic spectrum amplitude on the vertical (Y) axis. Via rear-panel connectors, a standard X-Y recorder can be connected for use as an alternate readout device to provide a permanent record.

The following review of data signal types and the corresponding spectra produced may be helpful for understanding the capabilities of the Spectrascope.

2.2.1 Time Domain Versus Frequency Domain

A standard laboratory oscilloscope displays the input signal in the time domain with a high degree of flexibility for setting or calibrating the time base. The SD330 can also display the input signal in the time domain, but since spectrum analysis is its primary function less flexibility is provided for setting the time base. Nine fixed time bases (selected by the ANALYSIS RANGE switch) and a TRIGGER LEVEL control are provided.

A Fourier analysis of the time-domain input signal transforms the signal into a frequency-domain spectrum for display. The spectrum analysis display consists of amplitude (Y axis) versus frequency (X axis). In widespread applications, the spectrum analysis allows a high degree of accuracy for identifying amplitude and frequency components (or periods) of complex signals. Table 2-1 shows several typical time functions and their corresponding spectra.

2.2.2 Linear and Logarithmic Displays

The SD330 X-axis display for frequency is a linear scale with the oscilloscope graticule divided into 10 equal increments. A logarithmic scale output for frequency is available at the rear panel for an external oscilloscope or X-Y recorder.

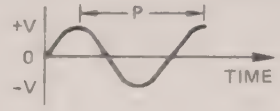
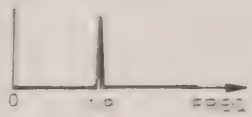
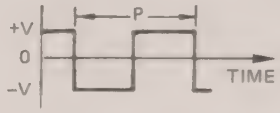
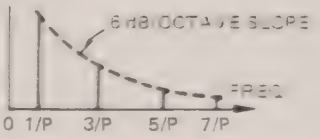
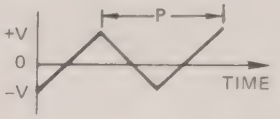
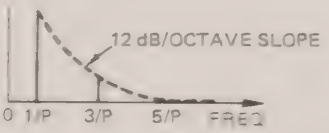
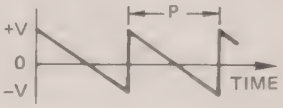
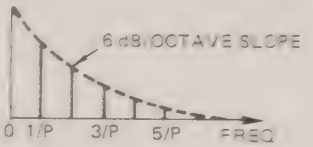
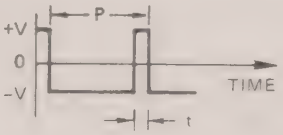
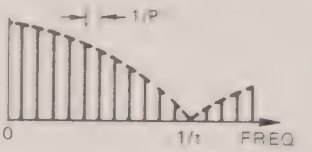
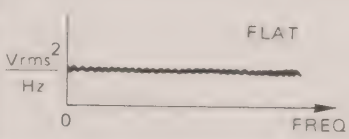
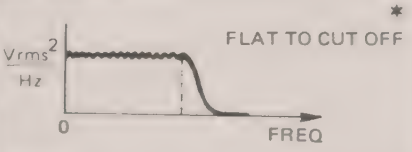
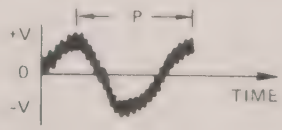
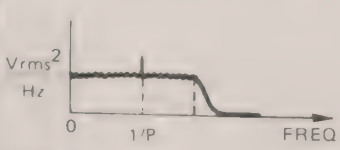
The SD330 Y-axis display is capable of both linear and logarithmic amplitude scales, selectable with front-panel push buttons. Output connectors for an external oscilloscope and X-Y recorder are available at the rear panel.

A typical linear amplitude calibration would be set to cover the full range of the oscilloscope graticule. Therefore, a sine wave input signal at 1/3 the calibration level (or at a level 10 dB below the calibration level) would produce a single spectrum line reaching a point 1/3 of full scale on the graticule.

A typical logarithmic amplitude calibration would be set so that a 10 dB change in amplitude would make a change of two divisions on the oscilloscope graticule. By applying the same signal described above, a small change in the display range would occur. One advantage inherent to this type of display is that lower level spectral components are more conspicuous and thus more easily detected. An alternate graticule or graph paper for X-Y recording would provide a logarithmic voltage scale that could be set to read 20 dB per decade (or 10 dB per decade if desired to measure power with the scale).

The SD330 INPUT RANGE/CAL coarse range push buttons are calibrated in voltage and dB steps of 10 dB with a full-scale 0 dB reference of 0.1 Vrms. The fine range push buttons allow 10 dB attenuation in steps of 1 dB. Table 2-2 shows voltage and corresponding ratios relative to dB for reference when comparing logarithmic and linear amplitude scales.

Table 2-1. Typical Signals as Seen on the SD330 Spectrascope Display

TYPE OF SIGNAL	TIME DOMAIN (FUNCTION)	FREQUENCY DOMAIN (SPECTRUM)
SINE WAVE		
SQUARE WAVE		
TRIANGULAR WAVE		
SAWTOOTH WAVE		
PULSE		
WIDEBAND GAUSSIAN RANDOM NOISE		
BAND-LIMITED OR FILTERED RANDOM NOISE		
SINE WAVE PLUS BAND- LIMITED RANDOM NOISE		

*Averaged Power Spectral Density (PSD)

V = volts t = time in seconds
P = period in sec. FREQ = frequency in Hz or RPS

Table 2-2. Decibel Table

dB*	Actual Reading**	Ratio†
0	1.00	1.00
-0.5	0.94	1.06
-1.0	0.89	1.12
-1.5	0.83	1.19
-2.0	0.79	1.26
-3.0	0.71	1.41
-4.0	0.63	1.58
-5.0	0.56	1.78
-6.0	0.50	2.00
-7.0	0.45	2.24
-8.0	0.40	2.51
-9.0	0.35	2.82
-10	0.32	3.2
-15	0.18	5.6
-20	0.10	10
-25	0.056	18
-30	0.032	32
-40	0.01	100
-50	0.0032	316
-60	0.001	1000
-80	10^{-4}	10000
-100	10^{-5}	10^{5}
-120	10^{-6}	10^{6}
-140	10^{-7}	10^{7}

*$dB = 20 \times \log \left(\frac{\text{Actual Reading}}{\text{Full Scale}} \right)$

**Actual Reading (Full Scale Normalized as 1.00)

†$\text{Ratio} = \frac{\text{Full Scale}}{\text{Actual Reading}}$

2.3 INITIAL POWERING PROCEDURE

NOTE

Before operating the instrument, study the functional description of the front panel and rear panel controls given in Section I of this manual.

a. Check that the 115/230 switch on the instrument rear panel is set according to the input line voltage and that a fuse of the correct value is installed.

b. Connect power cord to power source.

c. Press the POWER switch/indicator; it should light to indicate power is applied to all internal circuits.

2.4 OPERATIONAL CHECKOUT PROCEDURE

This procedure provides a complete operational checkout of the Model SD330 Spectrascope – Real Time Analyzer.

a. Apply power to the SD330 as described in Paragraph 2.3.

b. On the SD330, set the front panel controls as follows:

- AC/DC switch to AC
- Press INPUT RANGE/CAL .1 Vrms push button, and release 1, 2, 3 and 4 dB attenuation push buttons
- ANALYSIS RANGE selector to 20K
- Press CAL SPECT push button
- Press OUTPUT GAIN (dB) 0 push button
- Press Y DISPLAY LOG push button
- Press SCOPE SPECT push button
- Release FREQ MARKS and INTEN MARKS push buttons
- Release MEMORY HOLD/UPDATE push button so that UPDATE mode is activated (HOLD indicator is not lit).
- Release MANUAL push button
- DIGITAL LOCATER to 000
- Set all oscilloscope display controls to center position
- On Averager section,* release AVG push button and press STOP/STORE push button

c. Adjust the oscilloscope display INTENSITY, FOCUS, OFFSET and GAIN controls to obtain display illustrated in Figure 2-1. (Note that the Spectrascope may have an oscilloscope graticule other than that shown in the figure.)

NOTE

The Figure 2-1 spectrum display of the internally-generated calibration square wave signal shows logarithmic amplitude. When scaled so that the fundamental peak amplitude is 10 divisions above the baseline, a calibration of approximately 5 dB per division is established. It can be observed that the amplitude of the third harmonic is approximately two divisions below the amplitude of the fundamental.

*If applicable. (The Spectrascope may not have an averaging plug-in unit.)

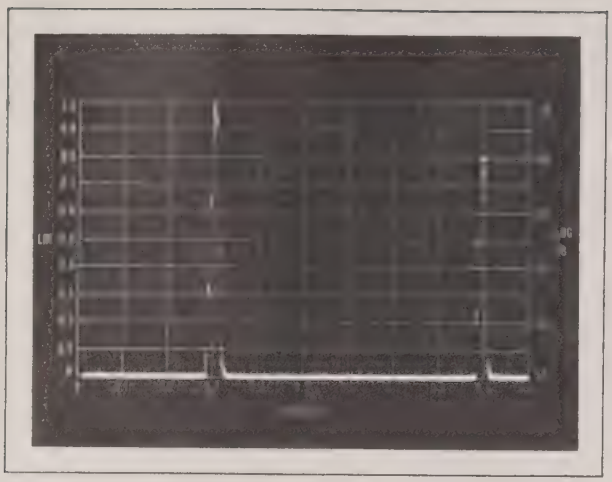


Figure 2-1. Calibration Signal

d. Set ANALYSIS RANGE selector to each of its positions and verify the same spectrum exists as obtained in Step c. (Note that when changing ranges, the display returns to normal following the memory period of the selected analysis range.) Set ANALYSIS RANGE selector to 5K position.

e. Press INPUT RANGE/CAL 1 Vrms push button and use Y OFFSET control to set peak of spectrum display at the –20 dB point. Press INPUT RANGE/CAL .1 Vrms push button and use Y GAIN control to set peak of spectrum display at full scale. Repeat these actions until a satisfactory calibration is achieved.

f. Consecutively press INPUT RANGE/CAL push buttons .316, 1, 3.16 and 10 Vrms, and verify display decreases in 10 dB steps. Then, with INPUT RANGE/CAL set to 1 Vrms range, consecutively press OUTPUT GAIN (dB) 10 and 20 push buttons and verify display increases in 10 dB steps. (Note that the baseline may not remain at the original level.)

g. Return OUTPUT GAIN (dB) to 0 and set INPUT RANGE/CAL to .1 Vrms range.

h. Sequentially press the INPUT RANGE/CAL fine attenuation 1, 2, 3, and 4 dB push buttons and verify corresponding sequential attenuation of 1, 3, 6 and 10 dB on the display.

i. Release all the fine attenuation push buttons.

j. Press SCOPE TIME push button. Then, using TRIGGER LEVEL control as required, observe the square wave display. Refer to Table 1-1 in Section I for time periods of the square wave on different frequency ranges.

k. Return instrument to SCOPE SPECT mode.

l. Press OPER, FREQ MARKS and INTEN MARKS push buttons.

m. Adjust FREQ CAL LO and HI as required to establish an intensity marker at the peak of each of the 10 frequency markers as illustrated in Figure 2-2. Note that the LO adjustment affects the position of all 10 markers and the HI affects the spread between markers. (For further details concerning the markers and the LO HI adjustments, refer to Section I.)

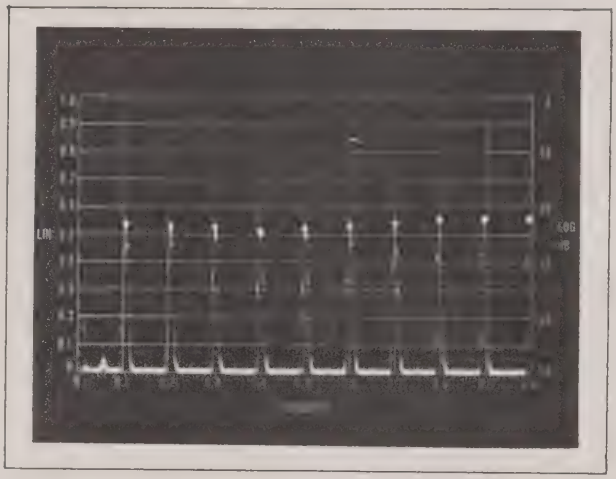


Figure 2-2. Intensified Dots Set at Top of Each of 10 Frequency Markers

n. Release FREQ MARKS and INTEN MARKS push buttons and press CAL SPECT push button.

o. Press MANUAL push button and observe display corresponds to Figure 2-3. (Note that if the FREQ CAL adjustments have been accurately performed, the dot should appear at the top of the display.)

p. Release MANUAL push button.

q. Press Y DISPLAY LIN push button and verify display corresponds to Figure 2-4 except the fundamental peak may not reach full scale. (Note that the display illustrated in Figure 2-4 can be achieved by adjusting the Y-GAIN and Y-OFFSET controls, if necessary. However, if these controls are adjusted, it will be necessary to repeat Step c. above prior to accomplishing the remaining steps of this procedure.)

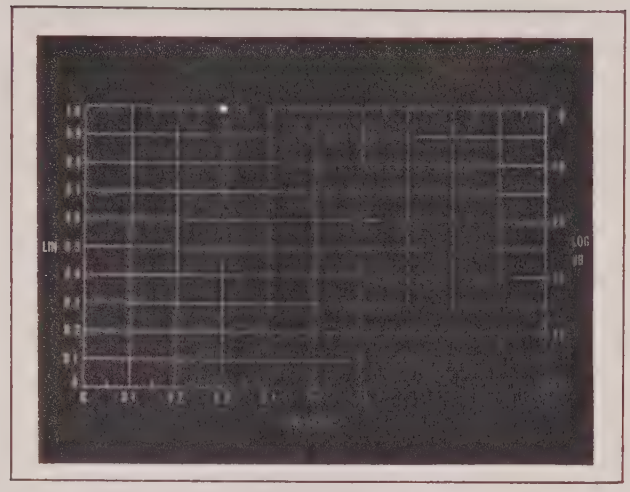


Figure 2-3. Full-Scale Calibration Signal in MANUAL Mode

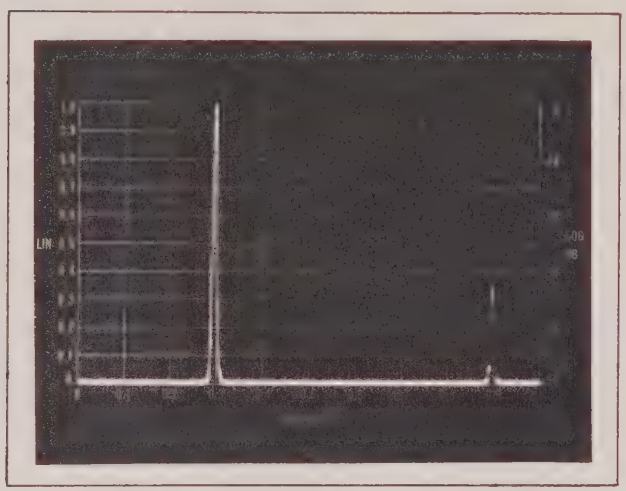


Figure 2-4. Calibration Signal with Linear Amplitude Scale Set to Cover Full Graticule Height

r. Press Y DISPLAY LOG push button.

s. Press CAL FREQ push button and observe dot at right edge of display.

t. Press CAL LIN ZERO push button and observe dot goes to left edge of display while push button is depressed.

u. Press INPUT RANGE/CAL .316 Vrms push button and verify dot moves to a point approximately 1/3 of the display range. Press 1 Vrms push button and verify dot moves to approximately 10 percent of display range. Press 3.16 Vrms push button, then the 10 Vrms push button and verify dot moves proportionally farther to left. (Note that the 1 Vrms range and 10 Vrms range are 1 and 2 decade steps down, respectively, from full-scale frequency and are used for establishing a log frequency scale.)

v. Return INPUT RANGE/CAL to the .1 Vrms range and press CAL SPECT push button.

w. Press PLOTTER RESET push button, then press PLOTTER SWEEP push button and verify that dot scans across the display and plots the spectrum of the internal calibration signal. (Note that the dot slows down at the spectrum lines because sweep rate feedback control is activated when high-amplitude variations are encountered.) The scan takes approximately 25 seconds. Upon completion, press SCOPE SPECT push button.

NOTE

This portion of the operational checkout procedure involves the Averager and therefore is not applicable if the Spectrascope does not have the averaging capability.

x. Press MEMORY HOLD/UPDATE push button and observe HOLD indicator remains lit.

y. Press OPER push button.

z. Select 128 averages by pressing NUMBER OF AVERAGES 4 and MULT X32 push buttons.

aa. Press AVG push button, then press START push button and observe that display builds up to the original full-scale value.

NOTE

While the display builds up, it varies between full scale and –6 dB because the average is normalized every binary step up to the selected number of averages.

Observe that STOP/STORE indicator lights following completion of the averaging cycle. The averaging time is the number of averages multiplies by the memory period, and in this case is 6.4 seconds (128 x 50 milliseconds = 6.4 seconds). The averaged spectrum is now stored in the Averager memory.

bb. Release MEMORY HOLD/UPDATE push button. Observe HOLD light goes out, but display does not change.

cc. Release AVG push button and observe display disappears.

dd. Press AVG push button and observe stored display reappears.

ee. Press EXPO AVG push button and observe display decays slowly and STOP/STORE indicator flashes.

ff. Press STOP/STORE push button and observe STOP/STORE indicator is continuously lit.

gg. Press PEAK HOLD push button and observe STOP/STORE indicator flashes.

hh. Press INPUT RANGE/CAL .316 Vrms push button and observe switching transient is stored due to PEAK HOLD mode. (Note that pressing additional INPUT RANGE/CAL push buttons updates the PEAK HOLD display.)

ii. Press STOP/STORE push button, observe indicator is continuously lit. Press PLOTTER RESET push button, then press PLOTTER SWEEP push button and observe dot scans the display and plots data stored in memory by the PEAK HOLD mode.

NOTE

When Plotting, the Averager STOP/STORE indicator must be lit prior to starting a sweep. And when started, a plotter sweep must be allowed to complete its cycle before returning instrument to SCOPE SPECT or PLOTTER RESET (red push button) mode. If PLOTTER SWEEP is interrupted, data will shift in memory.

jj. Press SCOPE SPECT push button and observe data stored in Averager is displayed.

kk. Release AVG push button and observe display disappears. (Note that data remains in the Averager memory until updated by pressing START or PEAK HOLD push button again.)

2.5 PREPARATION OF EXTERNAL DISPLAY DEVICES

Several display methods are available for immediate viewing and permanent recording of the spectrum data produced by the Model SD330 Spectrascope. Some of these methods are described in the following paragraphs.

2.5.1 X-Y Recorder

The following procedure describes set-up and calibration of a standard X-Y recorder. The procedure is presented in four parts with respect to the types of Y-axis and X-axis displays. Note that any standard X-Y recorder can be connected to the SD330 to obtain a permanent record of the spectrum data.

a. On SD330, set front-panel controls as prescribed in Paragraph 2.4, Step b. and, if required, perform Step c.

b. Perform Steps l. through p. of Paragraph 2.4.

c. Connect SD330 PLOTTER SPECT-Y output (connector J6) to X-Y recorder Y-axis input.

d. Connect SD330 PEN LIFT output (connectors J15, J16) to X-Y recorder external pen control input.

CAUTION

To prevent permanent damage to the pen-lift relay contacts in the SD330, be sure that a diode is installed across the pen lift solenoid coil in the recorder being used.

e. Perform procedural steps of Paragraphs 2.5.1.1 through 2.5.1.4, as applicable.

2.5.1.1 Linear Frequency (X-axis) Calibration

a. Connect SD330 PLOTTER LIN-X output (connector J7) to X-Y recorder X-axis input.

b. On SD330, press CAL FREQ push button.

c. On SD330, press PLOTTER RESET push button.

d. On X-Y recorder, energize servo. (Pen should move toward right edge of graph.)

e. On SD330, press and hold CAL LIN ZERO push button. On X-Y recorder, adjust X-axis zero control to set pen at frequency line on left edge of graph. Release CAL LIN ZERO push button.

f. On X-Y recorder, adjust X-axis variable gain to set pen at frequency line that represents full scale of the X-axis.

g. Repeat Steps e. and f. above (as required) to make final adjustment on X-Y recorder.

2.5.1.2 Log Frequency (X-axis) Calibration

a. Connect SD330 PLOTTER LOG-X output (connector J8) to X-Y recorder X-axis input.

b. On SD330, press CAL FREQ push button.

c. On SD330, press INPUT RANGE/CAL .1 Vrms push button.

d. On SD330, press PLOTTER RESET push button.

e. On X-Y recorder, energize servo. (Pen should move toward right edge of graph.)

f. On SD330, press INPUT RANGE/CAL 1 Vrms push button. (Pen of X-Y recorder should move toward center of graph.)

g. On X-Y recorder, adjust X-Axis zero control to set pen at line representing the frequency one decade below desired full-scale frequency. (For example, if data is to be plotted on the 2-kHz frequency range, the frequency one decade below 2 kHz is 200 Hz.)

h. On SD330, press INPUT RANGE/CAL .1 Vrms push button.

i. On X-Y recorder, adjust X-axis variable gain to set pen near desired full-scale frequency line.

j. Repeat Steps f. through i. above (as required) to make more accurate adjustments on the X-Y recorder.

k. Verify final accuracy of X-Y recorder by consecutively pressing INPUT RANGE/CAL 10, 1 and .1 Vrms push buttons and observing that X-Y recorder pen makes corresponding one-decade frequency step changes.

2.5.1.3 Log Amplitude (Y-axis) Calibration

a. On SD330, press MANUAL and CAL SPECT push buttons.

b. On X-Y recorder energize servo.

c. On SD330, press PLOTTER RESET push button. (Pen of X-Y recorder moves to calibration frequency at 30 percent of full scale on X-axis.)

d. On SD330, press INPUT RANGE/CAL 1 Vrms push button. (Pen of X-Y recorder should move toward bottom of graph.)

e. On X-Y recorder, adjust Y-axis zero control to set pen near desired –20 dB point on graph.

f. On SD330, press INPUT RANGE/CAL .1 Vrms push button.

g. On X-Y recorder, adjust Y-axis variable gain to set pen near desired 0 dB point.

NOTE

The desired –20 dB point on the graph can be determined as follows:

- If graph has logarithmic Y-axis, a –20 dB voltage change should be set to cover one decade. But, if plotting power spectral density (PSD) is desired, a 20 dB voltage change should be set to cover two decades of display.
- If graph has linear Y-axis, it may be desirable to calibrate so that each major division represents a 10 dB voltage change. (A 20 dB voltage change would therefore be set to cover two major divisions.)

h. Repeat Steps d. through g. above (as required) to make more accurate adjustments on the X-Y recorder.

i. Verify final accuracy of X-Y recorder by consecutively pressing INPUT RANGE/CAL .316, 1, 3.16 and 10 Vrms push buttons and observing that X-Y recorder pen moves accurately in response to the 10 dB/step changes.

2.5.1.4 Linear Amplitude (Y-axis) Calibration

a. On SD330, press Y DISPLAY LIN push button.

b. On SD330, press MANUAL push button.

c. On SD330, press PLOTTER RESET push button. (Pen of X-Y recorder moves to calibration frequency at 30 percent of full scale on X-axis.)

d. On X-Y recorder, energize servo. (Pen of X-Y recorder should move toward top of graph.)

e. On SD330, verify INPUT RANGE/CAL .1 Vrms push button is pressed.

f. On SD330, press and hold CAL LIN ZERO push button. On X-Y recorder, adjust Y-axis zero control to set pen at bottom line on graph. Release CAL LIN ZERO push button on SD330.

g. On X-Y recorder adjust Y-axis variable gain to set pen at desired full scale.

h. Repeat Steps f. and g. above (as required) to make final adjustment on X-Y recorder.

2.5.2 Display Oscilloscope

This procedure describes set-up and calibration of a display oscilloscope external to the SD330. The procedure is presented in two parts: X-Y display oscilloscope (such as Spectral Dynamics Model 13116-2), and standard Y-time oscilloscope equipped with a time-base generator. Note that any standard oscilloscope with external time base can be connected to the SD330 to obtain a spectrum display.

a. On SD330, set the front-panel controls as prescribed in Paragraph 2.4, Step b.

b. Connect SD330 SCOPE SPECT-Y output (connector J3) to external oscilloscope vertical (Y-axis) input.

2.5.2.1 X-Y Display Oscilloscope Calibration

NOTE

This procedure is also applicable to Spectral Dynamics X-Y Display Oscilloscope, Model 13116-2.

a. Connect SD330 SCOPE LIN-X output (connector J4) and/or SCOPE LOG-X output (connector J5) to display oscilloscope horizontal (X-axis) input.

b. Connect SD330 RETRACE BLANKING output (connector J9) to the display oscilloscope, if compatible. (To determine compatibility, refer to Section I of this manual and to the operation manual for the display oscilloscope.) Note that on the Spectral Dynamics X-Y Display Oscilloscope, Model 13116-2, connection should be made to RETRACE BLANKING input.

c. On SD330, press FREQ MARKS push button.

d. On X-Y display oscilloscope, set frequency markers to coincide with oscilloscope graticule lines. (Use oscilloscope zero-offset or position control, and gain or amplitude control.)

e. On SD330, release FREQ MARKS push button.

f. On SD330, press Y DISPLAY LIN or LOG push button as desired.

g. On X-Y display oscilloscope, set display to cover desired graticule display range. (Use zero-offset or position control, and gain or amplitude control.) Note that it may be desirable to set a linear spectrum display to cover the maximum display range; but a log spectrum amplitude display may be more meaningful if it is set so a 10 dB voltage change covers one major graticule division on the display. Either display may be set more accurately by pressing INPUT RANGE/CAL 10, 3.16, 1, .316, and .1 Vrms push buttons and making corresponding adjustments with oscilloscope display controls using a sequence similar to that prescribed in Paragraph 2.5.1 for the X-Y recorder.

2.5.2.2 Y-Time Oscilloscope Calibration

a. Connect SD330 SWEEP TRIGGER output (connector J11) to oscilloscope external trigger input.

b. Adjust oscilloscope time base for 5 ms/division and set to accept external trigger.

c. On SD330, press FREQ MARKS push button.

d. On oscilloscope, set frequency markers to coincide with oscilloscope graticule lines. (Use position control and time-base controls.)

e. Perform procedural Steps e., f., and g. of Paragraph 2.5.2.1. Note that if the SD330 INTEN MARKS push button is pressed when using the Y-time oscilloscope, a delay will occur at locations intensified on the SD330 display, slightly expanding the external display.

2.5.3 3-D Display Control/Oscilloscope

This procedure describes the instrument set-up required to obtain a three-dimensional display of spectrum data. The three dimensions are either frequency, amplitude and time, or frequency, amplitude and rpm. The equipment required to provide this type of display from the Spectrascope output consists of an SD25-80A 3-D Display Control and a memory oscilloscope. The memory oscilloscope specified in this procedure is a Tektronix Model 611 Storage Display Unit. This unit is recommended because of its large-screen display and ability, through expansion, to obtain a hard copy (permanent record) when used in conjunction with a Tektronix Model 4106 Hardcopy Unit. A typical three-dimensional data display is shown in Figure 2-5.

Figure 2-5. 3-D Spectrum Data Display

a. Connect instruments as shown in Figure 2-6. (Refer to the SD25-80A instruction manual for data concerning special cables.)

b. On SD25-80A, set SD301/SD330 switch to SD330 position.

c. On SD330, set front-panel controls as prescribed in Paragraph 2.4, Step b.

d. On SD25-80A, set RAMP to SLOW, MARKERS to OUT, DISPLAY TIME to HOLD detent, and select LIN X and LIN Y.

e. On SD25-80A, press RESET/START repeatedly while setting X, Y and Z OFFSET and GAIN controls and RAMP GAIN and TIME controls until a satisfactory display is obtained. Note that the Storage Display Unit may require INTENSITY, WRITE THROUGH, FOCUS AND OPERATING LEVEL adjustment. For detailed information and additional operating instructions pertaining to the specific instruments being used, refer to the separate instruction manuals.

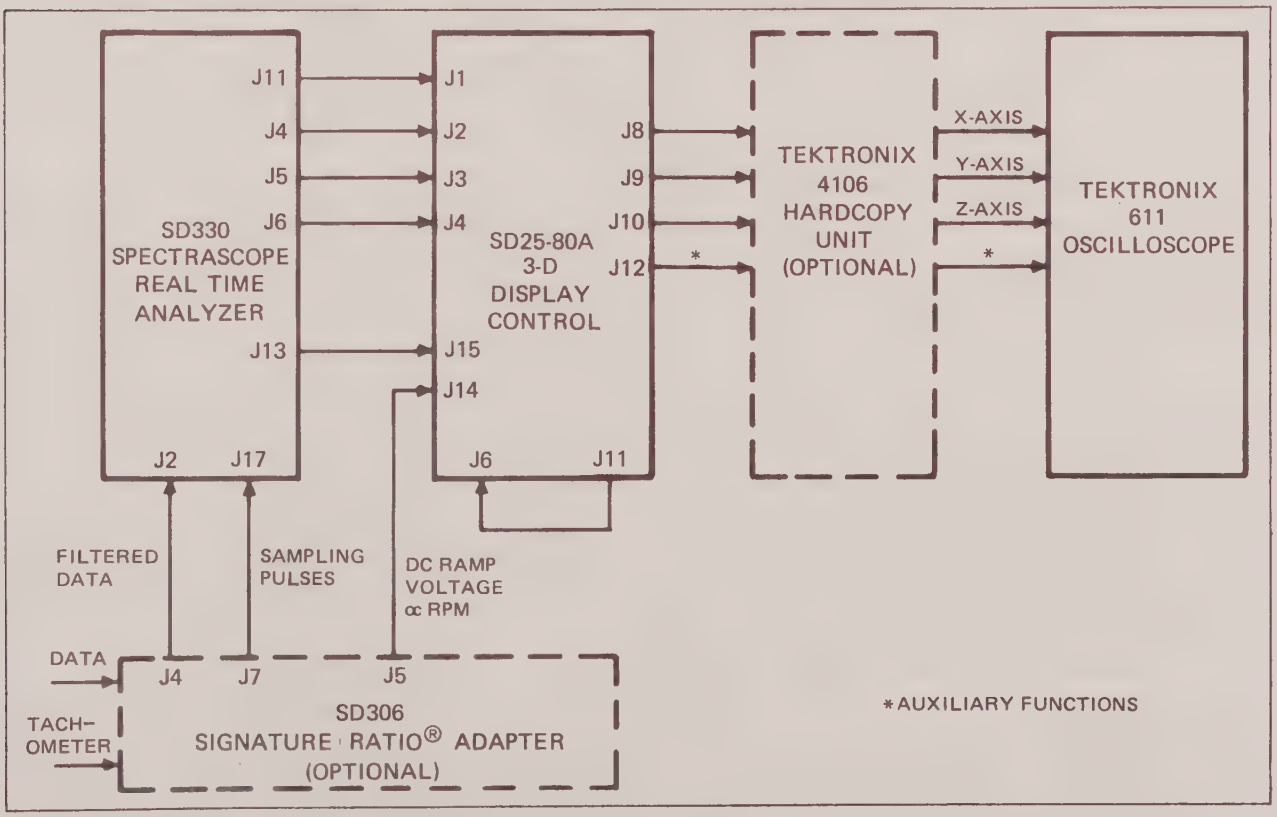


Figure 2-6. Instrument Setup for Obtaining 3-D Display

2.6 TYPICAL APPLICATIONS AND ASSOCIATED SETUP/CALIBRATION PROCEDURES

The following paragraphs contain examples of several typical applications of the SD330. The basic objective of these examples is to provide methods for obtaining a calibrated scale on the built-in display oscilloscope and on an external X-Y recorder.

Many types of signal transducers are available for converting mechanical energy to electrical signals. And many types of signal conditioning amplifiers can be obtained for amplifying or normalizing the transducer signals to volts or millivolts per engineering unit. Therefore, the following procedures refer to transducers and amplifiers in a general sense, without reference to specific types.

2.6.1 Analysis of Periodic Signal

This procedure for analysis of a periodic signal guides the operator through a typical operation in which an X-Y recorder is used. For this example it is assumed that a data signal is generated by an accelerometer attached to a running or vibrating specimen. It is also assumed that the conditioning amplifier is set to normalize the accelerometer signal to an output sensitivity of 100 mV rms/g rms (100 mV peak/g peak).

a. Apply power to the SD330 and X-Y recorder.

b. Connect SD330 PLOTTER SPECT Y output (connector J6) to recorder Y-axis input, and connect SD330 PLOTTER LIN X output (connector J7) to recorder X-axis input.

Verify that SD330 frequency output is properly calibrated. (Refer to Paragraph 2.4, Steps l. and m.)

NOTE

Use of linear graph paper with 7 x 10 major divisions is recommended.

c. Prepare the X-Y recorder for linear X-axis display and log Y-axis display in accordance with Paragraph 2.5.1. If linear graph paper is used as recommended in the Note above, calibrate the Y-axis of the recorder so that each major Y-axis division of the display represents a 10 dB change in voltage output, as suggested in the Note of Paragraph 2.5.1.3.

d. Set the SD330 front-panel controls as follows:

- AC/DC switch to AC
- Press INPUT RANGE/CAL 1 Vrms push button and release 1, 2, 3 and 4 dB push buttons
- ANALYSIS RANGE selector to 1K
- Press OPER push button
- Press OUTPUT GAIN (dB) 0 push button
- Press DISPLAY LOG push button
- Press averager STOP/STORE push button and release AVG push button
- Press SCOPE SPECT push button
- Release FREQ MARKS and INTEN MARKS push buttons
- Release MANUAL and MEMORY HOLD/UPDATE push buttons

e. Apply the data signal to the SD330 at the SIGNAL INPUT connector; adjust signal level with INPUT RANGE/CAL push buttons so that the INPUT meter indicates near full scale but OVERLOAD indicator does not light. This condition allows optimum use of the SD330 dynamic range. (Note that the highest spectrum peak on the display oscilloscope is near full scale.)

For the following example, assume that the INPUT RANGE/CAL 1 Vrms (20 dB) and 3 dB push buttons are depressed.

f. On SD330, press CAL SPECT push button. (The peak of the display represents a signal whose amplitude is 0.1 Vrms and, based on the above assumption, the peak is 23 dB below full scale.)

From Table 2-2 a full-scale amplitude of 1.41 Vrms is determined. Based on a signal sensitivity of 100 mV/g, the full-scale amplitude is 14.1 g rms (20 g peak). The amplitude of the calibration signal displayed is 1 g rms (1.41 g peak).

g. On SD330, press MANUAL push button and adjust FREQ CAL LO as required to establish the dot (intensified marker) at peak of spectrum line.

h. On SD330, press PLOTTER RESET push button.

i. On X-Y recorder, energize servo. Pen should move to the 300-Hz point and to an amplitude point 23 dB below full scale. Note that if a full-scale value other than 20 g peak is desired, pen position must be adjusted using the Y-axis zero control on the X-Y recorder.

j. Place the X-Y recorder in standby.

k. On SD330, release PLOTTER RESET and MANUAL push buttons.

l. On SD330, press OPER push button.

CAUTION

Because the INPUT RANGE/CAL and OUTPUT GAIN (dB) push buttons are in the calibration and operation signal path, both groups affect the level of the output signal. Therefore, if these push buttons can not be preset using the actual data signal as described in this procedure, any change of settings required after calibration must be compensated for by a corresponding amplitude change (in dB) on the recorder display graph.

m. On SD330, press MEMORY HOLD/UPDATE push button after data signal has been applied to the SIGNAL INPUT connector for at least one memory period. The display on the oscilloscope represents the Fourier analysis of the data input signal to 1 kHz, and this data is now stored in the SD330 memory.

n. On SD330, press PLOTTER RESET push button.

o. On X-Y recorder, energize servo.

p. On SD330, press PLOTTER SWEEP push button. With automatic pen lift connected, the pen will move down and the plot will immediately start.

The recorder will produce a record in the normal time plus any additional time required by sweep rate feedback.

At the end of the record, press SD330 PLOTTER RESET push button and, on X-Y recorder, deenergize servo.

q. On SD330, press SCOPE SPECT push button to present stored spectrum on display oscilloscope.

r. On SD330, release MEMORY HOLD/UPDATE push button. The SD330 will now accept new data for subsequent display and recording.

NOTE

If desired to use the averager section of the SD330 to obtain signal-to-noise ratio enhancement, perform Steps a. through l. above, then perform Steps s. through v. below.

s. On SD330, press AVG push button and press NUMBER OF AVERAGES 8 push button. Note that any number of averages up to 512 can be selected for this operation and that either EXPO AVG or PEAK HOLD can also be selected. (Refer to Section I for an explanation of these operating modes.)

t. On SD330, press START push button. At the end of the averaging time, the STOP/STORE indicator will light.

u. On SD330, press STOP/STORE push button, then repeat Steps n. through q. above.

v. On SD330, release AVG push button. The instrument will now accept new data for subsequent display, averaging and recording.

NOTE

Figure 2-7 shows a typical plot without averaging and Figure 2-8 shows a typical plot with averaging. **

2.6.2 Analysis of Rotating Machinery

2.6.2.I Introduction

This procedure for analysis of rotating machinery guides the operator through a typical operation in which an X-Y recorder is used and, as an option, a Model SD306 Signature Ratio® Adapter is used.

There are two meaningful techniques for analyzing rotating machinery with the Spectrascope. One technique employs the Spectrascope as a stand-alone instrument. In this case the procedure is the same as that given in Paragraph 2.6.1 for analysis of a periodic signal. To help interpret the display thus obtained, consider the following: All vibration components (spectrum lines on the display) related to rpm will change frequency as speed changes occur. But structural resonances will remain fixed in frequency since they are independent of rotational frequency. And, if a structural resonance is excited by a component related to the forcing frequency during start-up, for example, the amplitude of the structural resonance will increase as frequency of the exciting component passes through the frequency of the resonance. Moreover, if the vibration amplitude increases for extended periods at critical frequencies, destruction can result.

Table 2-3 contains information provided as a guide for identifying sources of vibration and noise. This data is not complete due to the depth of the subject, but is of value in making preliminary investigations.

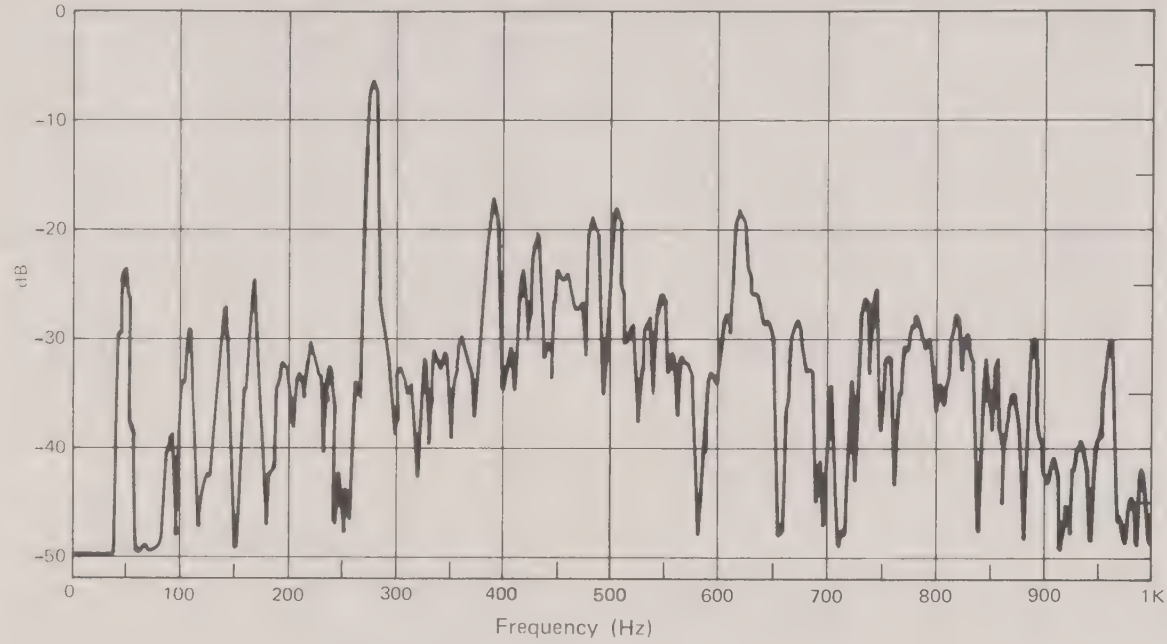


Figure 2-7. Typical Plot of Unaveraged Spectra

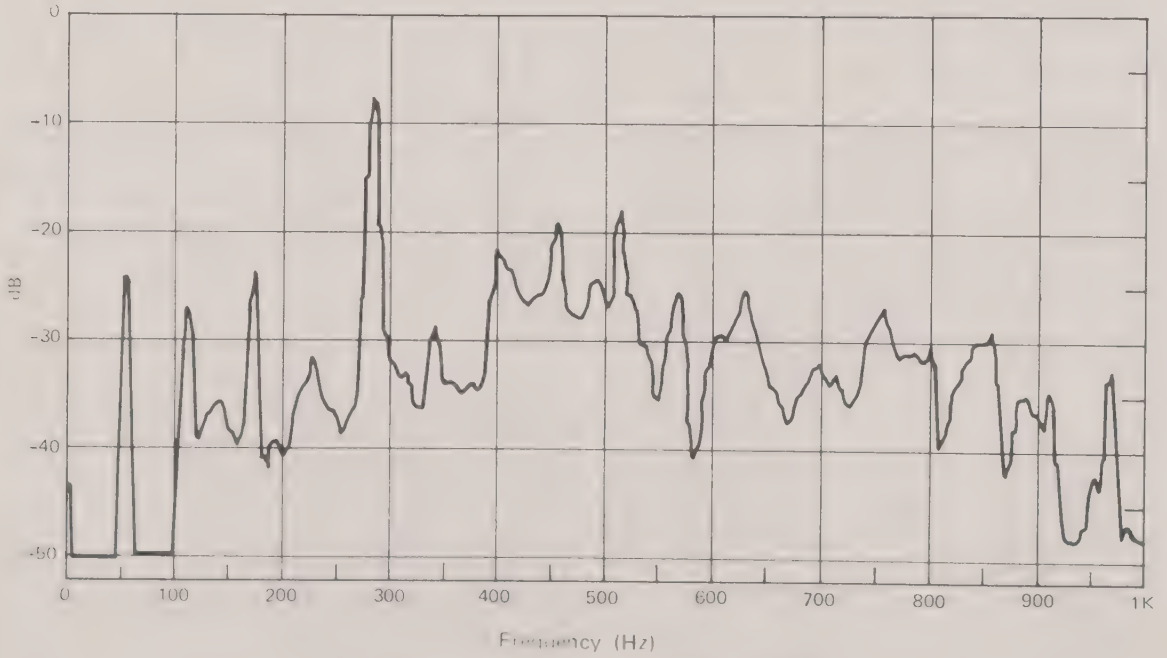


Figure 2-8. Typical Plot of Averaged Spectra

Table 2-3. Frequencies for Identifying Vibration and Noise Sources

GEARS

- Input Shaft Speed in Hz = $\frac{\text{Run Speed RPM}}{\text{60 Hz/min}}$
- Gear Mesh Frequency = Shaft Speed x No. of Teeth
- No. 2 Shaft Speed Frequency = $\frac{\text{Gear Mesh Frequency}}{\text{No. of Teeth (No. 2 Gear)}}$
- First Upper Sideband Frequency = Gear Mesh + Input Shaft Speed
- First Lower Sideband Frequency = Gear Mesh – Input Shaft Speed

BEARINGS

- Element Spin Frequency = $f_d \left(\frac{D_I}{D_I + D_O}\right) \left(\frac{D_O}{D_E}\right)$
- Element Train Passage Frequency = $f_d D_I$
- Rough Spot on Element Frequency = 2 x Element Spin Frequency
- Rough Spot on Inner Race Frequency = $f_d N D_O$
- Rough Spot on Outer Race Frequency = $f_d N D_I$

where:

N = No. of Elements
D_I = Diameter of Inner Race
D_O = Diameter of Outer Race
D_E = Diameter of Elements
f_d = Frequency Differential between Inner and Outer Race

MISCELLANEOUS VIBRATION

- Unbalance Frequency = 1 x Shaft Speed
- Misalignment Frequency = 2 x Shaft Speed
- Oil Whip Frequency = 1/2 x Shaft Speed
- Impeller Vanes Passage Frequency = No. Vanes x Shaft Speed
- Turbine Blades Passage Frequency = No. Blades x Shaft Speed

The other meaningful technique for analyzing rotating machinery with the Spectrascope provides for a frequency scale that is normalized to order-related multiples of operating speed. This technique requires use of the Model SD306 Signature Ratio® Adapter as an accessory instrument. The Model SD306 has provisions for operate/bypass modes, selection of input voltage range in volts rms, tachometer repetition rate in pulses per revolution, maximum order to be displayed, and a tachometer sensitivity adjustment.

In the operate mode, the SD306 provides a filtered data signal and a sampling pulse signal for input to the SD330. Refer to the SD306 instruction manual for specific details including a discussion of operating range and front-panel controls.

Two of the SD306 operational modes are described in following paragraphs.

2.6.2.2 Signature Ratio® Analysis

This procedure describes the instrument setup and operation required to obtain an oscilloscope display and X-Y recording on which the frequency range is determined by the SD306 to maintain order-related data. The data signal assumed for this example is the same as that assumed for Paragraph 2.6.1.

a. Apply power to the SD330, SD306 and X-Y recorder.

b. Connect instruments as shown in Figure 2-9. (Refer to the SD306 instruction manual for data concerning special cables.)

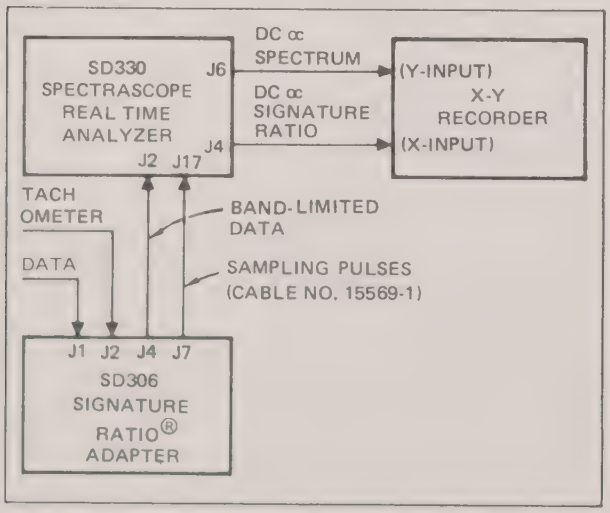


Figure 2-9. Instrument Setup for Signature Ratio® Analysis

c. On SD306, press MODE BYPASS push button.

d. Perform Steps b. through l. of Paragraph 2.6.1.

e. On SD306, set INPUT RANGE Vrms to the same range determined for the coarse INPUT RANGE/CAL attenuator on the SD330 in Step e. of Paragraph 2.6.1.

f. On SD306, press the TACH PULSES/REV push button that corresponds to tachometer repetition rate, set ORDERS MAX switch to 5 and press MODE OPER push button.

g. On SD330, press INPUT RANGE/CAL .316 Vrms push button.

NOTE

The level of the full-scale filtered output signal from the SD306 is 0.316 Vrms. Therefore, calibration amplitude determined in Paragraph 2.6.1 is maintained by performing Steps e. and g. above. However, if the SD306 OVERLOAD indicator lights during this procedure after performing Step f. above, press the next higher attenuation push button on the SD306 and make a corresponding change on the scales of the display oscilloscope and X-Y recorder.

h. On SD330, set ANALYSIS RANGE selector to 20K position.

i. With machinery running, adjust SD306 TACH SENSITIVITY control as required. Note that a conditioned tachometer output is available at a rear-panel connector for monitoring with an oscilloscope to determine the correct sensitivity position, if required.

j. With machinery running to produce desired spectrum display, perform Steps m. through u. of Paragraph 2.6.1. Note that the resulting X-Y record has a frequency scale with a maximum frequency that is the 5th order of machinery running speed.

2.6.2.3 RPM Tracking Analysis

This procedure describes the instrument setup and operation required for rpm tracking analysis. This setup allows an X-Y record to be made of vibration amplitude versus rpm. The vibration amplitude can be any order of rotation. Order is determined by the SD330 DIGITAL LOCATER thumbswitch which is set in conjunction with the ORDERS MAX control on the SD306. The data signal assumed for this example is the same as that assumed for Paragraph 2.6.1.

a. Apply power to the SD330, SD306 and X-Y recorder.

b. Connect instruments as shown in Figure 2-10. (Refer to the SD306 instrument manual for data concerning special cables.)

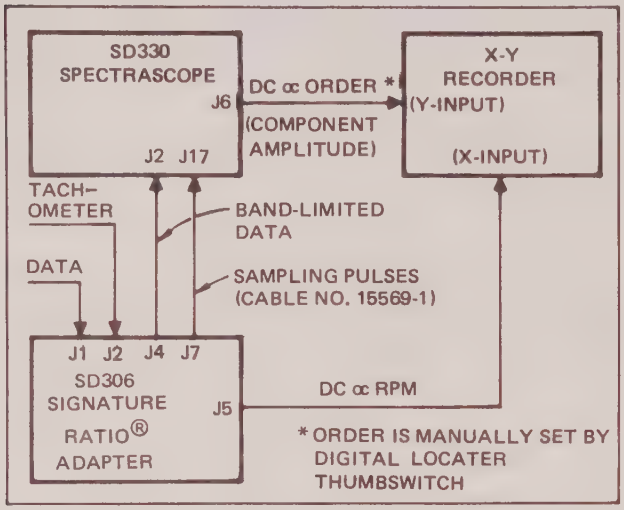


Figure 2-10. Instrument Setup for RPM Tracking Analysis

c. On SD306, press MODE BYPASS push button.

d. Perform Steps b. through l. of Paragraph 2.6.1, except perform calibration of X-axis of recorder in accordance with procedural steps below.

e. Calibration of the X-Y recorder X-axis can be enabled by either running the rotating machine at full rpm or by substituting an oscillator signal for the tachometer signal and simulating full rpm. Apply the chosen signal to the SD306 TACH input (connector J2) and maintain constant frequency while performing Steps f., g., and h. below.

f. On X-Y recorder, energize servo and set pen to desired full-scale point using X-axis gain control.

g. On X-Y recorder, remove X-axis input and set pen to 0-rpm point using X-axis zero control.

h. On X-Y recorder, reconnect X-axis input and repeat Steps f., g. and h., if required.

i. Deenergize X-Y recorder servo. If an oscillator signal was connected to the SD306 in Step e. above, disconnect the signal and reconnect the tachometer signal.

j. On SD306, set INPUT RANGE Vrms to the same range determined for the coarse INPUT RANGE/CAL attenuator on the SD330 in Step e. of Paragraph 2.6.1.

k. On SD330, press INPUT RANGE/CAL .316 Vrms push button.

NOTE

The level of the full-scale filtered output signal from the SD306 is 0.316 Vrms. Therefore, calibration amplitude determined in Paragraph 2.6.1 is maintained by performing Steps j. and k. above. However, if the SD306 OVERLOAD indicator lights during this procedure after performing Step p. below, press the next higher attenuation push button on the SD306 and make a corresponding change on the scales of the display oscilloscope and X-Y recorder.

l. On SD306, press the TACH PULSES/REV push button that corresponds to tachometer repetition rate and set ORDERS MAX switch to 5.

m. On SD330, press MANUAL push button.

n. On SD330, set DIGITAL LOCATER to 200. This setting represents 20 percent of the SD306 ORDERS MAX control setting which, in this case, is 20 percent of 5. This action establishes that the 1st-order component will be plotted versus rpm. It is emphasized that other order-related components can be set, based on a percentage of the maximum orders selected on the SD306.

o. On SD330, set ANALYSIS RANGE selector to 20K position. This prevents the anti-aliasing filter in the SD330 from interfering with the anti-aliasing filter in the SD306.

p. On SD306, press MODE OPERATE push button.

q. On X-Y recorder, energize servo.

r. With the machinery running at low rpm and with data and tachometer signals applied to the SD306, press SD330 PLOTTER RESET push button.

s. Accelerate the rotating machine through its operating speed range at a slow, uniform rate, or as determined by observing the X-Y recorder. The X-Y recorder will produce a record of the 1st order of vibration amplitude versus speed range. Note that the SD330 sampling rate is slow at low rpm but increases as speed increases. Also note that to prevent slewing errors, ample time must be allowed for sampling and analysis over the entire speed range.

t. At upper limit of machine speed range, press SCOPE-SPECT push button to release SD330 PLOTTER RESET push button. This action causes the pen to lift, thus, machine speed can be reduced without marking the X-Y graph.

2.6.3 Analysis of Acoustic Data

This procedure for analysis of acoustic data guides the operator through a typical operation in which an X-Y recorder is used. Specifically, sound pressure level is analyzed using constant-bandwidth filtering. For this example, assume that an on-line analysis is being performed and that a Sound Level Calibrator with an output of 114 dB at 250 Hz is available. Also assume that the output level of the signal conditioning amplifier is 500 mV rms with the above calibration signal applied, based on an output sensitivity of 5 mV per microbar.

a. Apply power to the SD330 and X-Y recorder.

b. Connect SD330 PLOTTER SPECT Y output (connector J6) to recorder Y-axis input, and connect SD330 PLOTTER LIN X output (connector J7) to recorder X-axis input.

Verify that the SD330 frequency output is properly calibrated. (Refer to Paragraph 2.4, Steps l. and m.)

NOTE

Use of linear graph paper with 7 x 10 major divisions is recommended.

c. Prepare the X-Y recorder for linear X-axis display and log Y-axis display in accordance with Paragraph 2.5.1. If linear graph paper is used as recommended in the Note above, calibrate the Y-axis of the recorder so that each major Y-axis division of the display represents a 10 dB change in voltage output, as suggested in the Note of Paragraph 2.5.1.3.

d. Set the SD330 front-panel controls as follows:

- AC/DC switch to AC
- Press INPUT RANGE/CAL 1 Vrms push button and release 1, 2, 3 and 4 dB push buttons
- ANALYSIS RANGE TO 1K
- Press OPER push button
- Press OUTPUT GAIN 0 (dB) push button
- Press Y DISPLAY LOG push button
- Press STOP/STORE push button and release AVG push button
- Press SCOPE SPECT push button
- Release FREQ MARKS and INTEN MARKS push buttons
- Release MANUAL and MEMORY HOLD/UPDATE push buttons

e. Apply the calibration signal (from the Sound Level Calibrator) to the microphone and connect the output of the signal conditioning amplifier to the SD330 SIGNAL INPUT connector. Observe that spectrum line at 250 Hz on the display is 6 dB below full scale.

f. Press MEMORY HOLD/UPDATE push button. The calibration signal is now stored in the SD330 memory.

g. Remove the Sound Level Calibrator signal.

h. Press MANUAL push button, then use the DIGITAL LOCATER to manually tune the SD330 to the calibration signal. When tuned to the calibration signal, the dot will be at the peak of the spectrum line observed in Step e. above.

i. Press PLOTTER RESET push button.

j. On X-Y recorder, energize servo. Pen should move to 250 Hz. With the Y-axis zero control, set the pen on the graph at the point where the 114 dB calibration point is desired.

CAUTION

Because the INPUT RANGE/CAL and OUTPUT GAIN (dB) push buttons are in the calibration and operation signal path, both groups affect the level of the output signal. Therefore, any change of settings required after calibration must be compensated for by a corresponding amplitude change (in dB) on the recorder display graph.

k. On X-Y recorder, deenergize servo.

l. Press SCOPE SPECT push button and release MANUAL push button.

m. Release MEMORY HOLD/UPDATE push button. The Spectrascope is now ready to accept acoustic data.

n. On SD330, set ANALYSIS RANGE to desired upper frequency.

o. On SD330, press MEMORY HOLD/UPDATE push button after data signal has been applied to the SIGNAL INPUT connector for at least one memory period. The display on the oscilloscope represents the Fourier analysis of the data input signal over the frequency range selected, and this data is now stored in SD330 memory.

p. On SD330, press PLOTTER RESET push button.

q. On X-Y recorder, energize servo.

r. On SD330, press PLOTTER SWEEP push button. With automatic pen lift connected, the plot will immediately start.

The recorder will produce a record in the normal time plus any additional time required by sweep rate feedback.

At the end of the record, press SD330 PLOTTER RESET push button and on X-Y recorder, deenergize servo.

s. On SD330, press SCOPE SPECT push button to present stored spectrum on display oscilloscope.

t. On SD330, release MEMORY HOLD/UPDATE push button. The SD330 will now accept new data for subsequent display and recording.

NOTE

If desired to use the averager of the SD330 to obtain signal-to-noise ratio enhancement, perform Steps a. through n. above, then perform Steps u. through y. below.

u. On SD330, press AVG push button and press NUMBER OF AVERAGES 8 push button. Note that any number of averages up to 512 can be selected for this operation and that either EXPO AVG or PEAK HOLD can also be selected. (Refer to Section I for an explanation of these operating modes.)

v. On SD330, press START push button. At the end of the averaging time, the STOP/STORE indicator will light.

w. On SD330, press STOP/STORE push button.

x. Repeat Steps p. through s. above.

y. On SD330, release AVG push button. The instrument will now accept new data for subsequent display, averaging and recording.

2.6.4 Analysis of Random Data (PSD Analysis)

2.6.4.1 Introduction

For analyzing signals with random content, an estimate of long-term power spectrum (or PSD characteristics) is desirable. The Averager of the SD330 can provide the desired estimate of the average spectrum characteristics of a random signal by performing frequency domain averaging. The averager examines successive ensembles of spectrum functions and computes the averaged sum over a predetermined length of time.

Accuracy of the average spectral content, determined by averaging ensembles of spectrum functions, is governed by a parameter known as the statistical degrees of freedom (n). This quantity can be computed as $n = 2BT$, where B is the analysis bandwidth and T is the length of time in seconds over which a data sample is examined.

Since on any given analysis range of the SD330, the analysis bandwidth, B, is essentially the reciprocal of the digital memory circulation period, T, it can be stated that, for practical purposes, $B = \frac{1}{T}$. This means that on any analysis range, the product BT is always equal to approximately 1. Since the number of degrees of freedom (n) equals 2BT, it can be seen that each statistically independent spectrum analysis produces a spectrum estimate with 2 degrees of freedom. Thus, the statistical accuracy achieved by averaging is improved as the selected number of averages is increased and the number of degrees of freedom of an analysis is equal to twice the selected number of averages.

To establish a calibration level when using the SD330 for PSD analysis, either the internal calibration signal or an externally applied calibration signal can be used. Both methods are described in the following paragraphs.

In the following examples of data analysis, a flat random signal in the frequency range of 10 to 2,000 Hz at a level of 0.2 g^2/Hz is assumed. Then, from g rms = $\sqrt{g^2/Hz \times BW}$, the overall level of 20 g rms is established. Effective BW is approximately 13 Hz on the 2K ANALYSIS RANGE. (Refer to Table 2-4.)

2.6.4.2 Understanding the PSD Plot

When measuring random signals, the rms value (or mean squared value) is examined because theoretically the instantaneous peak values can be infinitely high due to

Table 2-4. Memory Parameters

ANALYSIS RANGE UPPER LIMIT (Hz)	NOMINAL BANDWIDTH (3 dB FILTER) (Hz)	RESOLUTION* (Hz)	NOMINAL EFFECTIVE (NOISE) BANDWIDTH** (Hz)	MEASURED EFFECTIVE (NOISE) BANDWIDTH (Hz)
20,000	120	80	130	
10,000	60	40	65	
5,000	30	20	32.5	
2,000	12	8	13	
1,000	6	4	6.5	
500	3	2	3.25	
200	1.2	0.8	1.3	
100	0.6	0.4	0.65	
25	0.15	0.1	0.162	

*Spacing of filter locations

**If maximum accuracy is required, the effective (noise) bandwidth should be determined by measurement.

the nature of the signal. Also, since the plot represents power (Power Spectral Density or, energy under the curve), it is more meaningful when presented on a squared scale. This is accomplished by calibrating the scale so that a 10 dB voltage change represents a 1-decade change on the graph allowing volts^2 or g^2 to be plotted (directly governed by dB = 10 log $\frac{P1}{P2}$). The term g^2/Hz is used to define a level of random acceleration and is independent of bandwidth. But, when an analyzer is prepared for measurement of random data, analyzer bandwidth is a part of the calibration formula, and is therefore compensated for. A plot of g^2/Hz over some frequency range is then meaningful, even when going from analyzer to analyzer or when changing ranges of the analyzer. The frequency resolution may vary but the "shape" or plot profile will remain the same.

Figure 2-11 shows a typical test requirement in which a profile of energy distribution is specified. The dashed lines indicate upper and lower tolerance levels that typically are ±3 dB. However, with respect to these tolerance levels, there is a governing factor because +3 dB is double the test level and such a deviation is not the intention of the test engineer. This factor is that the overall g rms test level is given a tolerance of ±10 percent, as read on a broadband true rms meter. Typical test specifications state that the g^2/Hz level can exceed the ±3 dB limits as long as the frequency band in which the excursion occurs is less than 300-Hz wide and if the overall g rms level remains within ±10 percent. Some examples for reading a PSD plot are given in following paragraphs.

Figure 2-12 shows how the overall g rms level can be determined for this "shaped" spectrum. The solution is not presented in detail but it can be derived by finding the g rms levels of each of the sections (① through ⑤) using g rms = $\sqrt{g^2/Hz \times BW}$. In sections ④ and ⑤ only half of the measured BW should be used in the formula since the level follows a curve. The total or overall level is then found as the square root of the sums of the squares of the levels determined for each section. This will give a close approximation since, as stated above, the levels in sections ④ and ⑤ follow a curve. On the log scale the lines are straight but on a linear scale the lines are curved and asymptotic to 6 dB/octave.

Another common test (Figure 2-13) requires that a 20 g rms random signal, over the range of 10 Hz to 2,000 Hz, be mixed with a 10 g peak sine wave at 1 kHz. To keep everything in equal terms, the rms value of the sine wave is found and the level of the sine wave, as seen by the analyzer (based on its filter bandwidth) must then be found. Perform this task as follows:

a. Determine rms g level of sine component:

10 g peak x 0.707 = 7.07 g rms

b. Determine overall test level to be read:

$$g\ rms\ overall = \sqrt{random\ level^2 + sine\ level^2}$$

$$\sqrt{400 + 50}$$

$$= 21.2$$

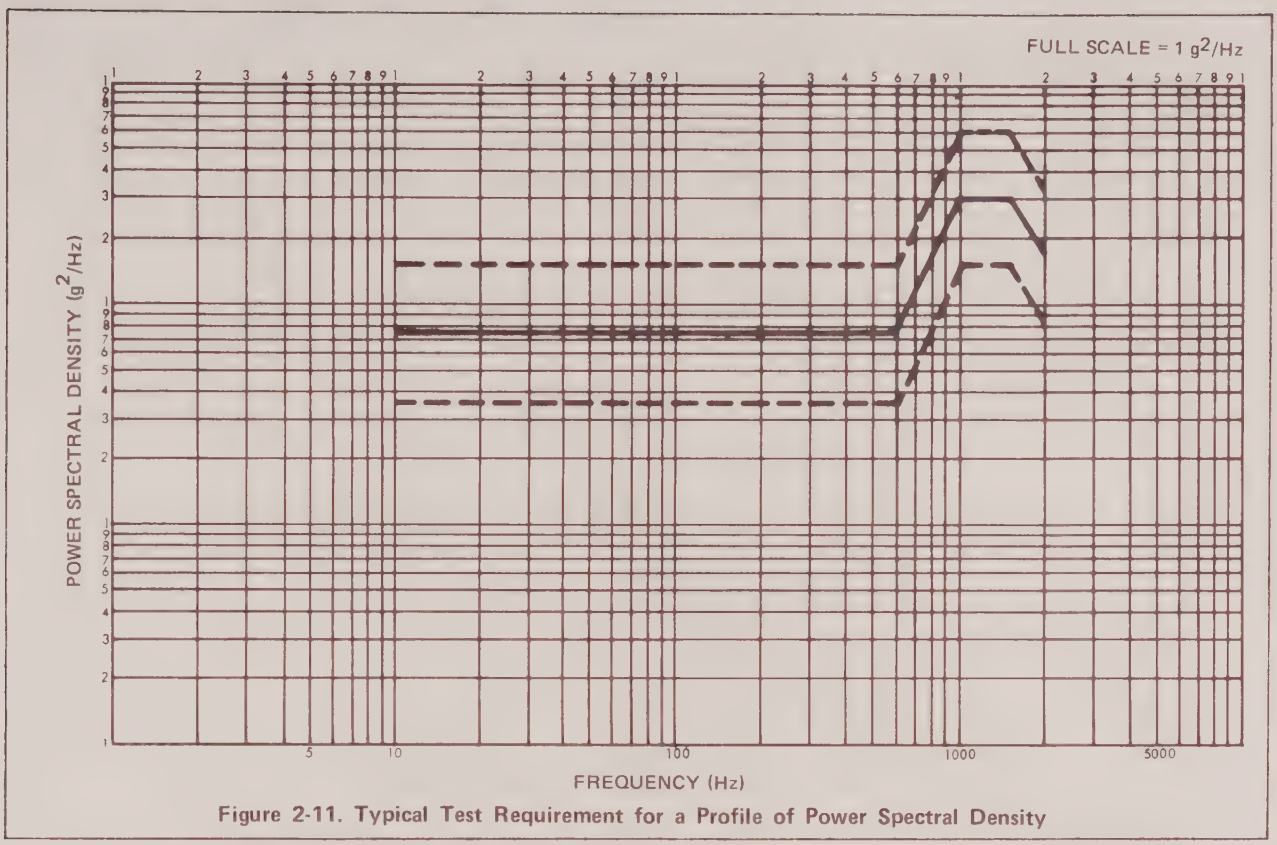


Figure 2-11. Typical Test Requirement for a Profile of Power Spectral Density

c. Determine the g^2/Hz level of the random signal:

$$g^2/Hz = \frac{(g\ rms \times 1.13)^2}{BW}$$

$$= \frac{400}{2000}$$

$$= 0.2$$

d. Determine the g^2/Hz level of sine wave (dependent on analyzer filter bandwidth):

$$g^2/Hz = \frac{(g\ rms)^2}{BW}$$

$$= \frac{50}{13}$$

$$= 3.84$$

e. Determine the combined g^2/Hz level to be read on the X-Y plot at 1 kHz:

g^2/Hz (random) = 0.2

g^2/Hz (sine) = 3.84

Total = 4.04

2.6.4.3 PSD Calibration Using the Internal Cal Signal

This procedure describes calibration of an X-Y recorder. For this example, assume that the random data signal of 20 g rms is "on-line" and based on a sensitivity of 10 mV rms/g rms.

a. Apply power to the SD330 and X-Y recorder.

b. Connect SD330 PLOTTER SPECT Y output (connector J6) to recorder Y-axis input, and connect SD330 PLOTTER LIN X output (connector J7) to recorder X-axis input.

Verify that the SD330 frequency output is properly calibrated. (Refer to Paragraph 2.4, Steps l. and m.)

NOTE

Graph paper with a 2 or 3-decade log scale for amplitude should be used. The frequency axis can be either linear or log, as desired.

c. Prepare the X-Y recorder for linear or log X-axis, and log Y-axis. Calibrate the Y-axis so that a 10 dB change in input voltage produces a 1-decade change on

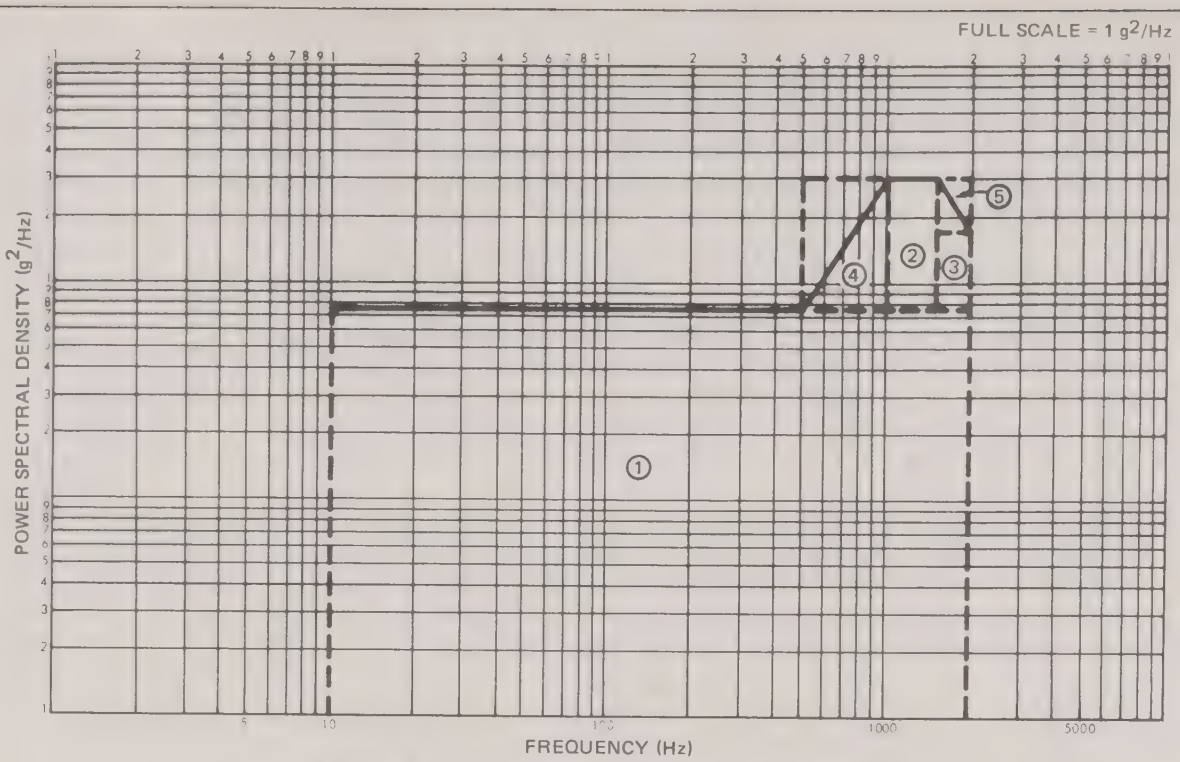


Figure 2-12. Determination of Overall g rms Level

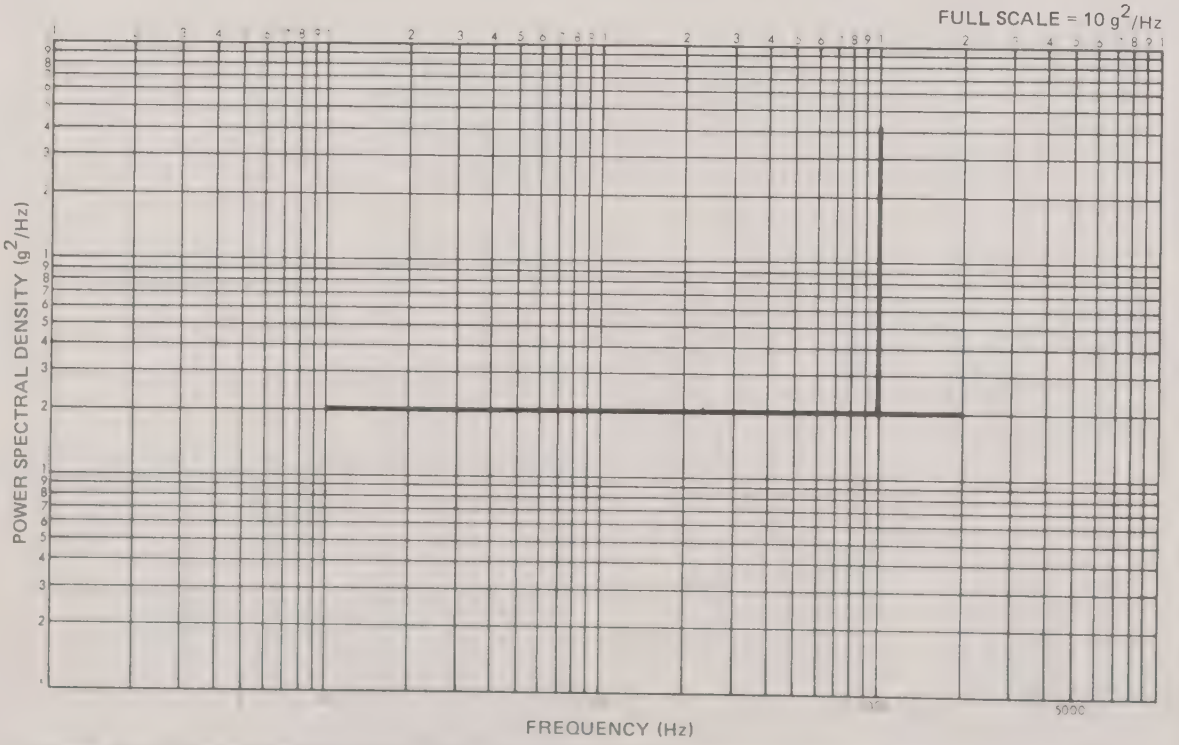


Figure 2-13. Typical Test Requirement Showing a Flat PSD Spectrum Combined with a Periodic Signal

the graph to establish a 2 x log g (or log g^2) condition. (Refer to Paragraph 2.5.1.)

d. Set the SD330 front-panel controls as follows:

- AC/DC switch to AC
- ANALYSIS RANGE to 2K
- Press OPER push button
- Press Y DISPLAY LOG push button
- Press STOP/STORE push button and release AVG push button
- Press SCOPE/SPECT push button
- Release FREQ MARKS and INTEN MARKS push buttons
- Release MANUAL and MEMORY HOLD/UPDATE push buttons

e. Apply the data signal to the SIGNAL INPUT connector, then preset operating parameters as follows:

1. Press INPUT RANGE/CAL .316 Vrms push button and the 4 dB attenuator push button for an INPUT meter indication near full scale with only occasional input overload conditions (indicated by input OVERLOAD light).

2. Press OUTPUT GAIN (dB) 0, 10 or 20 push button to establish the maximum usable post-filter gain without experiencing an output overload condition. (Output OVERLOAD indicator does not light.)

These actions permit full use of the SD330 dynamic range and establish an optimum condition for random signal analysis.

CAUTION

Because the INPUT RANGE/CAL and OUTPUT GAIN (dB) push buttons are in the calibration and operation signal path, both groups affect the level of the output signal. Therefore, any change in settings required after calibration must be compensated for by a corresponding amplitude change (in dB) on the recorder display graph.

f. Establish the g^2/Hz level by using the internal calibration source of the Spectrascope as follows:

$$\text{Calibration level} = \frac{(\text{g rms} \times 1.13)^2}{\text{Effective BW (from Table 2-4)}}$$

NOTES

1. The factor of 1.13 is used above since the SD330 employs quasi-peak* detection. The resulting relationship "rms random = 1.13 x rms sine" must therefore be considered when calibrating with a sine wave.

   *quasi-peak = envelope rectifier followed by sampling detector.

2. Effective bandwidth on the 2K ANALYSIS RANGE is approximately 13 Hz.

3. Amplitude of the internal calibration signal of the SD330 is always 100 mV rms.

Therefore:

$$\text{Calibration Level} = \frac{(10 \text{ g rms} \times 1.13)^2}{13}$$

$$= \frac{127.69}{13}$$

$$= 9.82 \text{ g}^2\text{/Hz}$$

From the above (assuming 10 mV/g sensitivity), the following can be established:

INPUT RANGE/CAL Levels

0 dB (reference level)	= 9.82 g^2/Hz
−10 dB (next higher range)	= 0.982 g^2/Hz
−20 dB (next higher range)	= 0.0982 g^2/Hz
−30 dB (next higher range)	= 0.00982 g^2/Hz
−40 dB (next higher range)	= 0.000982 g^2/Hz

g. On SD330, press the INPUT RANGE/CAL push button which represents the g^2/Hz calibration level that is in the same decade as the expected data level. For this example, the .316 Vrms range push button would be pressed (−10 dB represents 0.982 g^2/Hz) but the fine attenuator push buttons would not be changed.

h. On SD330, press CAL SPECT push button, MANUAL push button and PLOTTER RESET push button. Verify dot is at peak of spectrum by adjusting FREQ CAL LO control.

i. On X-Y recorder, energize servo and adjust the Y-axis with the zero control so that the pen aligns with 0.982 g^2/Hz in the upper decade of the graph. After adjusting the recorder, deenergize the servo. On SD330, press OPER push button and press INPUT RANGE/CAL push button determined in Step e. above. (In this example, the .316 Vrms push button remains depressed.)

j. On the SD330, press SCOPE SPECT push button and release MANUAL push button.

k. On SD330, press NUMBER OF AVERAGES 2 and MULT X32 push buttons. (This selects 64 averages for a statistical accuracy of 128 degrees of freedom.) With the data signal applied to the input of the SD330, press AVG push button then press START push button.

NOTES

1. Averaging time is a product of the memory period and the chosen number of averages. In this example, averaging time is 8 seconds, (0.125 sec x 64). The data signal must therefore be applied to the SD330 for at least 8 seconds. (Use memory period of 50 ms to calculate averaging time when on 10K and 20K ranges.)
2. Upon completion of the averaging process, the STOP/STORE indicator will light to signify that the averaged spectrum is stored in the averager memory.

l. On SD330, press STOP/STORE push button.

m. On SD330, press PLOTTER RESET push button.

n. On X-Y recorder, energize servo.

o. On SD330, press PLOTTER SWEEP push button to start recording. In this example, the average amplitude of the record should be 0.2 g^2/Hz.

2.6.4.4 PSD Calibration Using External Cal Signal

If an external calibration signal from a reference oscillator is to be used to establish a specific full-scale graph g^2/Hz level, the calibration procedure is the same as Paragraph 2.6.4.3, except Steps f. through i. For these exceptions, substitute steps are given below.

Assume for this example that the signal to be analyzed is the same 20 g rms random data signal with a sensitivity of 10 mV rms/g rms assumed for Paragraph 2.6.4.3.

Perform Steps a. through e. of Paragraph 2.6.4.3, then proceed as follows:

SUBSTITUTE FOR STEP f.:

Establish the calibration reference level as follows:

Since the data level is expected to be 0.2 g^2/Hz, select 1 g^2/Hz for full scale on the recorder graph.

Determine external calibration g rms level for full scale.

$$\text{Calibration Level } (g \text{ rms} \times 1.13)^2 = \text{Full Scale} \times \text{Effective BW (Refer to Table 2-4.)}$$

$$\text{Full Scale Calibration g rms} = \frac{\sqrt{1 \times 13}}{1.13}$$

$$= \frac{3.61}{1.13}$$

$$= 3.19$$

From the above, find external calibration mV rms for full scale.

$$\text{Full Scale Calibration mV rms} = \text{Signal Sensitivity} \times \text{Calibration g rms}$$

$$= 10 \text{ mV rms/g rms} \times 3.19 \text{ g rms}$$

$$= 31.9 \text{ mV rms}$$

SUBSTITUTE FOR STEP g.:

To the SD330 SIGNAL INPUT, apply a 1-kHz calibration signal at the full-scale calibration mV rms level as calculated above.

SUBSTITUTE FOR STEP h.:

On SD330, press MANUAL and PLOTTER RESET push buttons. Then, with the DIGITAL LOCATER, manually tune the SD330 to 1 kHz.

SUBSTITUTE FOR STEP i.:

On X-Y recorder, energize servo. Make sure that the signal level is at the "peak" of the filter by observing the pen level indication on the X-Y recorder while slightly varying the oscillator frequency.

Adjust the Y-axis of the recorder with the zero control so that the pen indicates full scale on the graph. After adjusting the recorder, deenergize servo.

Continue procedure of Paragraph 2.6.4.3, commencing with Step j.

2.6.4.5 PSD Calibration Using Tape Recorded Cal Signal

If a tape recorded calibration signal is available that is representative of a known g rms level, the calibration procedure is the same as Paragraph 2.6.4.3, except Steps f. through i. For these exceptions, substitute steps are given below.

The example used in this procedure assumes that a 1-kHz sine wave calibration signal at a level representing 20 g rms has been recorded together with the example 20 g rms random data signal. To calibrate, perform Steps a. through e. of Paragraph 2.6.4.3, then proceed as follows:

Establish the calibration g^2/Hz level as follows:

Measure the rms level of the recorded calibration signal to determine sensitivity of the tape recorder (or data signal sensitivity). For this example, assume that 200 mV rms was measured.

$$\text{Signal Sensitivity} = \frac{\text{Tape Output Level}}{\text{Calibration Level}}$$

$$= \frac{200 \text{ mV rms}}{20 \text{ g rms}}$$

$$= 10 \text{ mV/g}$$

Determine the g^2/Hz calibration level:

$$\text{Calibration} = \frac{(\text{g rms} \times 1.13)^2}{\text{Effective BW (from Table 2-4.)}}$$

$$= \frac{(20 \times 1.13)^2}{13}$$

$$= 39.3 \ g^2/\text{Hz}$$

Now determine the INPUT RANGE/CAL setting required for the calibration signal. During data analysis, the setting would be .316 Vrms because the data signal was assumed to measure 200 mV rms. But, during calibration, the setting would be 3.16 Vrms because the calibration signal is approximately 20 dB or 2 decades higher (39.3 g^2/Hz versus 0.2 g^2/Hz).

SUBSTITUTE FOR STEP g.:

To the SD330 SIGNAL INPUT, apply the tape recorded calibration signal.

SUBSTITUTE FOR STEP h.:

On SD330, press MANUAL push button and PLOTTER RESET push button. Then, with the DIGITAL LOCATER, manually tune the SD330 to 1 kHz.

SUBSTITUTE FOR STEP i.:

On X-Y recorder, energize servo. Make sure that the signal level is at the "peak" of the filter by observing the pen level indication on the X-Y recorder while varying the FREQ CAL LO adjustment on the SD330.

With the recorder zero control, calibrate the Y-axis so pen aligns with 0.393 g^2/Hz in the upper decade of the graph.

After recorder is calibrated, deenergize servo and on SD330, press INPUT RANGE/CAL push button determined in Step e. of Paragraph 2.6.4.3.

Continue procedure of Paragraph 2.6.4.3, commencing with Step j.

2.6.4.6 Determining Effective Noise Bandwidth for Analysis

Effective squared (or noise) bandwidths become important in power spectrum analysis because measured spectrum levels are squared values (and thus the shape of the analysis filter is essentially squared in terms of the resulting spectrum display).

Table 2-4 lists the effective squared bandwidth (nominal value) for each analysis range of a typical SD330 Spectrascope – Real Time Analyzer. However, before commencing a program of power spectrum measurements, it is recommended that a measurement be made of the filter on the analysis range to be used. Several techniques are available for performing this measurement; one involves plotting the actual filter shape, squaring the resulting ordinate values and determining the area under the curve or the "effective squared bandwidth." A simpler approach is possible if the necessary equipment is available to the operator. (See Figure 2-14.)

The simpler approach requires an easy manipulation of the calibration equation for power spectrum analysis given in Paragraph 2.6.4.3, Step f. (The calibration equation states that Cal g^2/Hz $= \frac{(\text{g rms} \times 1.13)^2}{\text{effective BW}}$.) The procedure for this technique involves the following basic steps:

1. A relative calibration level (in terms of span and offset on an X-Y recorder) is established.

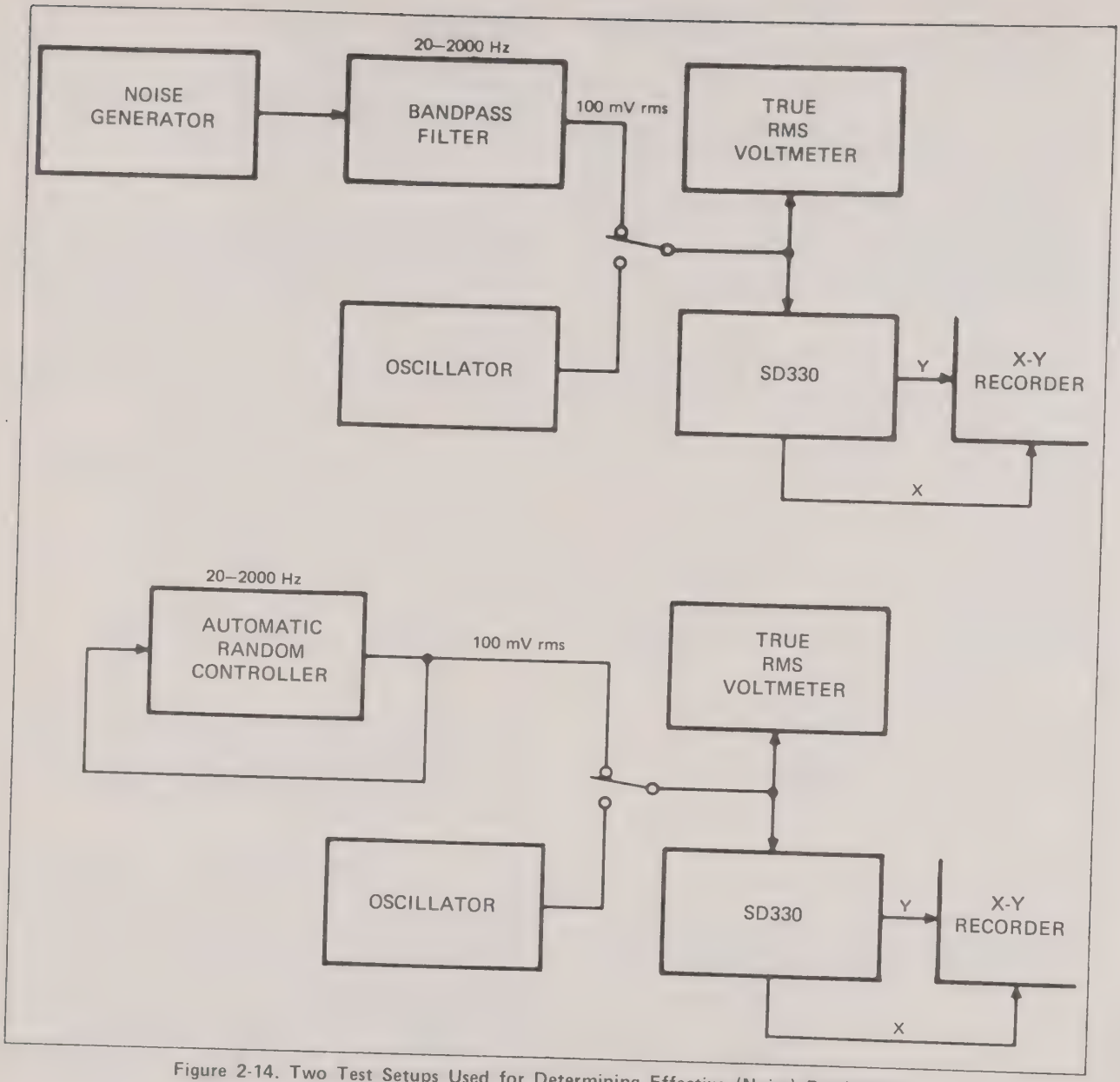


Figure 2-14. Two Test Setups Used for Determining Effective (Noise) Bandwidth

2. A known power spectrum (g^2/Hz) level is established.

3. The sinusoidal level equivalent to the power spectrum level established in Step 2 above is substituted.

For example, by using one of the test setups illustrated in Figure 2-14, a random noise signal (limited to a 20-Hz to 2-kHz band) is established. If the level of this signal is set to 100 mV rms, a known power spectrum is established. And, if a sensitivity of 10 mV rms/g rms is assumed, the established level corresponds to a test level of 10 g rms over the selected 2-kHz bandwidth. The test level therefore corresponds to a known spectrum level of 0.05 g^2/Hz ($g^2/Hz = \frac{g\ rms^2}{data\ BW}$). The internal calibration signal of the SD330 can then be used to establish the span of the X-Y recorder. Continue in accordance with the following procedure:

a. Set the span so that a 10 dB change in Spectrascope input signal produces a 1-decade power output display on the X-Y recorder.

NOTE

At this point in the procedure, it is not important where the zero point is set, but it is important that a true dB/decade relationship has been established.

b. Apply the 100 mV random signal to the SD330. Set the SD330 ANALYSIS RANGE selector to the 2K position.

NOTE

If the analysis procedure is performed correctly (without overload, but with sufficient input and output gain), a power spectrum display with either 64 or 128 averages will represent a smooth spectrum shape.

c. Record the spectrum on the X-Y recorder with the zero adjustment of the recorder set so that the spectrum is displayed in the top decade of the graph.

d. Remove the random noise signal and apply a 1-kHz (approximate) sine wave signal. Tune the analyzer to the exact frequency of the sine wave by selecting the MANUAL mode and using the DIGITAL LOCATER.

NOTE

In the following Step, vary the oscillator frequency slightly to ensure that it is at the "peak" of the filter while making the final level adjustment.

e. Adjust the level of the sine wave until the recorder pen reaches the same level as the flat portion of the spectrum recorded in Step c. above. This establishes an equivalent power spectrum level. The level of the input sine wave now corresponds to an equivalent power spectrum level of 0.05 g rms^2/Hz.

f. With the rms voltmeter, measure the sine wave level required to bring the recorder pen to the level specified in Step e. above. The operator can now quickly establish the following calibration equations: (Assume for this example that the rms voltmeter indicates a level of 7.4 mV rms.)

$$\text{Cal } g^2/\text{Hz} = \frac{(\text{g rms} \times 1.13)^2}{\text{effective BW}}$$

In the above equation, all terms are known quantities except effective squared bandwidth for which the equation can be rewritten as:

$$\text{Effective BW} = \frac{(0.74 \text{ g rms} \times 1.13)^2}{0.05} = 13.98 \text{ Hz}$$

The result of this computation is a direct indication of effective squared bandwidth for the filter of the 2-kHz analysis range.

2.6.5 Transient Recording

Since the Spectrascope incorporates the basic capability for capturing and storing data, it can serve as a transient recorder. A speeded-up replica of the input time function, with low-pass filtering added, is preserved in digital memory for viewing or photographing. Virtually any standard laboratory oscilloscope is turned into a storage oscilloscope since the stored data is outputed on a continuous basis.

a. Apply power to the SD330 and external oscilloscope.

b. Connect the instruments as shown in Figure 2-15.

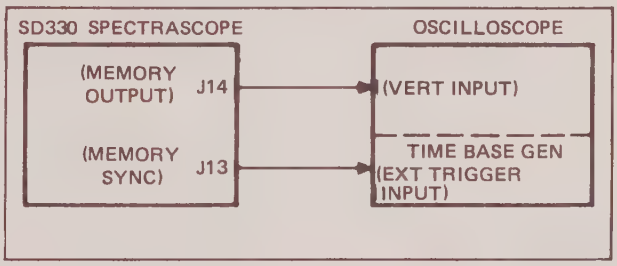


Figure 2-15. Setup for Viewing Memory Contents

c. On the oscilloscope, set the time base generator to 20 μs/division and set it to accept an external trigger (the SD330 MEMORY SYNC pulse).

Set the vertical amplifier for 200 mV/division, A-C coupled.

NOTE

One circulation period of the SD330 digital memory is 200 μs. Thus, one period is displayed on the oscilloscope and this presentation is rapidly changing when the SD330 is not in the HOLD mode.

d. Set the SD330 front-panel controls as follows:

- AC/DC switch to AC

- Press INPUT RANGE/CAL 1 Vrms push button and release 1, 2, 3 and 4 push buttons
- ANALYSIS RANGE selector to 1K
- Press OPER push button
- Press STOP/STORE push button and release AVG push button
- Press SCOPE SPECT push button
- Release FREQ MARKS and INTEN MARKS push buttons
- Release MANUAL and MEMORY HOLD/UPDATE push buttons
- DIGITAL LOCATER to 750

e. On SD330, press CAL SPECT push button and then press MEMORY HOLD/UPDATE push button.

Observe a square wave displayed on the oscilloscope. Make adjustments on oscilloscope vertical amplifier, if desired.

f. On SD330, press OPER push button and release MEMORY HOLD/UPDATE push button.

g. Apply the data signal to the SD330 SIGNAL INPUT connector. Adjust signal level with INPUT RANGE/CAL push buttons so that the INPUT meter provides an indication but the input OVERLOAD indicator does not light.

h. On SD330, press TRANS CAPT push button and set TRIGGER LEVEL control to a threshold voltage level above any noise level that exists. (A trial and error process may be required to develop operator familiarity with the TRIGGER LEVEL control.)

NOTES

1. With the Spectrascope properly set and the TRANS CAPT push button pressed, 750 samples of the input signal will load into memory after the signal exceeds the threshold level to generate the transient capture trigger. Upon completion of loading, the HOLD indicator lights and the oscilloscope displays the stored data.

2. A built-in delay in the MEMORY SYNC signal allows the stop/start or truncation point of the memory to be displaced from the edge of the display. Figure 2-16 shows how to interpret the oscilloscope display.

3. If it is desirable to move the data away from the truncation zone, a number such as 650 should be set on the DIGITAL LOCATER before pressing the TRANS CAPT push button. This activates the HOLD mode after 650 samples are taken following the trigger point.

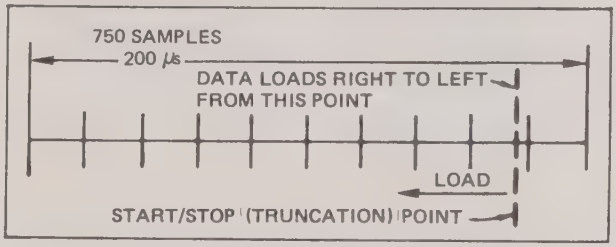


Figure 2-16. Oscilloscope Display Showing Approximate Zone of Truncation as Determined by Oscilloscope Trigger Setting

i. On SD330, press TRANS CAPT push button when it is time to accept new data. This puts the SD330 back into the UPDATE mode and resets the trigger circuitry.

2.6.6 Transient Analysis

2.6.6.1 Introduction

The Spectrascope is well suited to providing the Fourier analysis of a transient signal. This paragraph explains and illustrates that the capability of the Fourier analysis for accurate measurement of frequency is dependent on the number of cycles or samples at given frequencies.

Figure 2-17 shows the results obtained when the SD330 is set up in accordance with Paragraph 2.6.5 and one cycle of a 500-Hz signal is used as the transient signal. Figures 2-18 and 2-19 show the results obtained with 2 and 3 cycles, respectively. These three figures illustrate the classical $\frac{\sin x}{x}$ functions that are a part of the Fourier analysis process. As the number of cycles or samples increases, the spectrum line becomes better defined with the side lobes becoming smaller and eventually falling below the dynamic range of the analyzer.

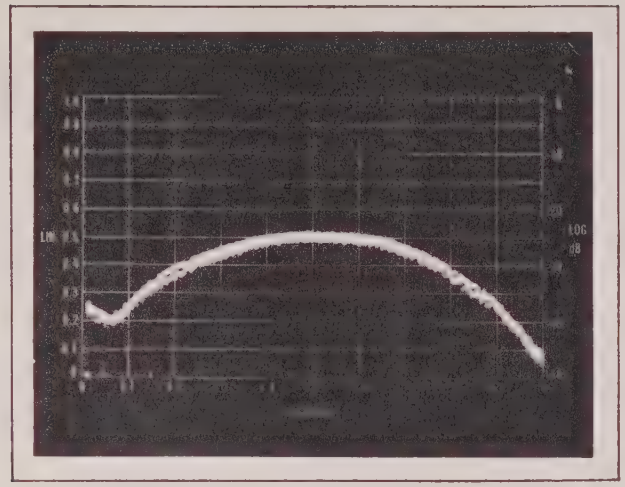


Figure 2-17. Spectrum of 1 Cycle of a 500-Hz Signal

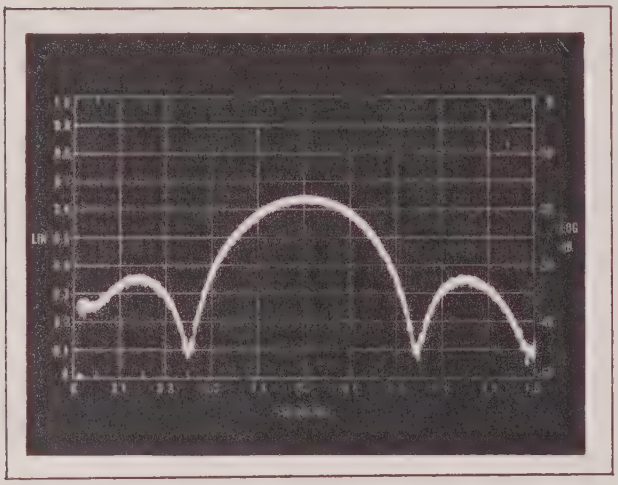


Figure 2-18. Spectrum of 2 Cycles of a 500-Hz Signal

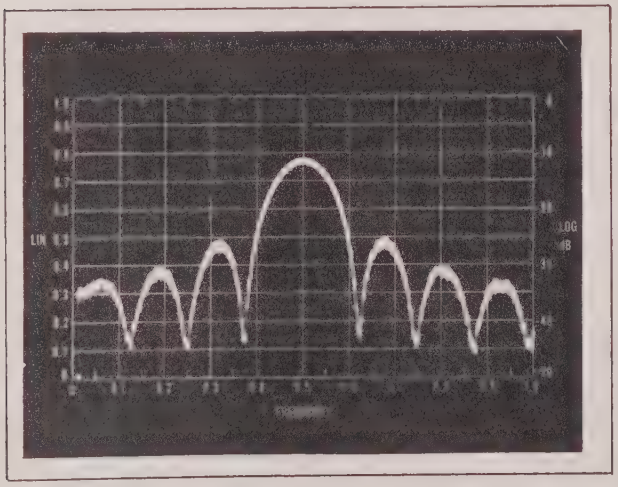


Figure 2-19. Spectrum of 4 Cycles of a 500-Hz Signal

2.6.6.2 Determining the Resonant Frequency of Structures

This procedure describes a technique for measuring the dynamic response characteristics of a structure by using the Spectrascope in the transient capture mode. For this example, assume the data signal is from an accelerometer, a strain gage or a microphone. If an accelerometer is used, it is important that its weight be significantly less than the structure to avoid damping or distorting the data.

a. Perform Steps a. through i. of Paragraph 2.6.5.

NOTE

During transient analysis, it is beneficial to have an external oscilloscope connected and set to monitor the memory contents for two reasons: to be certain that the appropriate signal is being analyzed and that the analyzer weighting function is not attenuating the signal. The effect of the weighting function, a necessary process in an analyzer with finite memory, is illustrated in Figure 2-20.

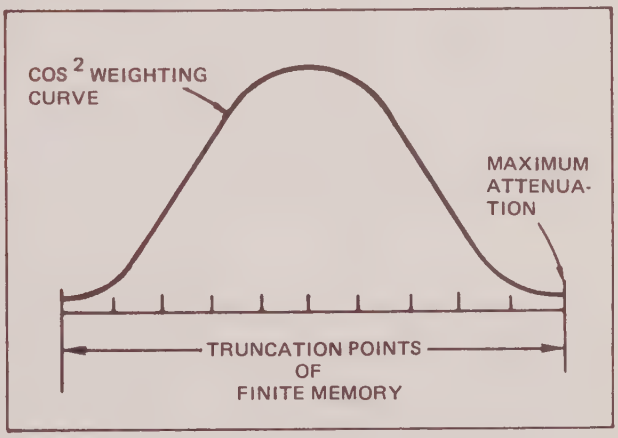


Figure 2-20. Effect of Weighting Function

b. On SD330, set DIGITAL LOCATER to a number that allows the predominant signal to be positioned in the area where little or no attenuation occurs. A setting of 300 to 400 is suggested.

c. On SD330, press TRANS CAPT push button.

d. With the instrumentation amplifier or power supply turned on, strike the structure with a non-metallic object causing it to respond at its natural resonant frequency or frequencies.

Table 2-5. Input/Output Signal Data for AUXILIARY FUNCTIONS Connector, J17

PIN	SIGNAL NAME	PIN	SIGNAL NAME
1	*10% FREQ SHIFT (input)	20	EXT SAMPLING FREQ (input); Z_{in} = 10 KΩ
2	*EXT SAMPLING CONTROL (input)	21	*DIGITAL OUTPUT BIT 3 (output)
3	*25 Hz ANALYSIS RANGE SELECT (output)	22	*DIGITAL OUTPUT BIT 4 (output)
4	*100 Hz ANALYSIS RANGE SELECT (output)	23	*DIGITAL OUTPUT BIT 5 (output)
5	*200 Hz ANALYSIS RANGE SELECT (output)	24	*DIGITAL OUTPUT BIT 6 (output)
6	*500 Hz ANALYSIS RANGE SELECT (output)	25	*DIGITAL OUTPUT BIT 7 (output)
7	*1 kHz ANALYSIS RANGE SELECT (output)	26	*DIGITAL OUTPUT BIT 8 (output)
8	*2 kHz ANALYSIS RANGE SELECT (output)	27	*DIGITAL OUTPUT BIT 9 (output)
9	*5 kHz ANALYSIS RANGE SELECT (output)	28	*DIGITAL OUTPUT BIT 10 (LSB) (output)
10	*10 kHz ANALYSIS RANGE SELECT (output)	29	*WORD SYNC (output)
11	*20 kHz ANALYSIS RANGE SELECT (output)	30	*ENABLE D-A OUTPUT (input)
12	TRANS CAPT SELECT (output)	31	*SWEEP SYNC (output)
13–17	SPARES	32	SPARE
18	*DIGITAL OUTPUT BIT 1 (MSB) (output)	33–35	GND
19	*DIGITAL OUTPUT BIT 2 (output)	36	LIN STEP SPECTRUM (output), 0–5V; Z_{out} is less than 200Ω

*TTL Compatible

Following automatic capture, the HOLD indicator will light, the stored transient can be observed on the external oscilloscope to show its position in memory and, the internal oscilloscope of the SD330 will display the Fourier spectrum analysis of the transient.

e. Repeat Steps b., c. and d. above until satisfactory results are obtained. Try different settings of the ANALYSIS RANGE selector to be certain of maximum coverage.

f. On SD330, press INTEN MARKS and, using DIGITAL LOCATER, set the intensified dot to the peaks of the spectrum lines and identify their frequencies by reading percent of the ANALYSIS RANGE setting indicated on the DIGITAL LOCATER. For example, the setting of 348 (34.8 percent) when on the 1K ANALYSIS RANGE equals 348 Hz.

2.7 AUXILIARY FUNCTIONS IDENTIFICATION AND SPECIAL CABLE REQUIREMENTS

Several auxiliary functions are available via the AUXILIARY FUNCTIONS connector (J17) on the rear panel. Table 2-5 lists the pins of connector J17 and identifies the signals that can be supplied to the SD330 from external sources or can be supplied by the SD330 to external instruments. Special cables for interconnecting J17 with ancillary equipment manufactured by Spectral Dynamics Corporation can be obtained from Spectral Dynamics Corp. For cable information refer to the separate instruction manuals for ancillary equipment.

2.8 GENERAL REFERENCE DATA

Tables 2-6 through 2-11 and Figure 2-21 contain reference data provided for the convenience of the instrument user.

Table 2-6. Engineering Terms and Interrelationships

Term	Symbol	Relationship to Other Terms
Acceleration: Vector acceleration in gravity units	g	$g = 0.0511f^2D$
Velocity: Velocity in inches per second	V	$g = 0.0162Vf$
Frequency: Frequency in Hz	f	$V = \pi fD$
Displacement: Displacement in inches peak to peak	D	$V = 61.44g/f$

Table 2-7. Time Duration of 1 Cycle

1 Hz	1 sec
10 Hz	100 ms
100 Hz	10 ms
1 kHz	1 ms
10 kHz	100 μs
100 kHz	10 μs

Table 2-8. Measurement of Displacement, Velocity, and Acceleration

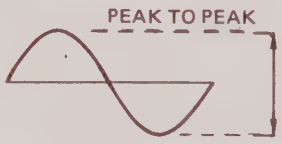
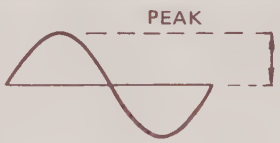
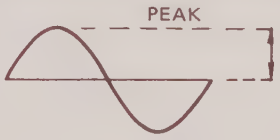
DISPLACEMENT (INCHES)	 DOUBLE AMPLITUDE
VELOCITY (INCHES/SEC)	 SINGLE AMPLITUDE
ACCELERATION (g)	 SINGLE AMPLITUDE

Table 2-10. Acceleration Decibels and Velocity Decibels

Acceleration Decibels = adB =

$$20 \log_{10} \frac{\text{measured acceleration in rms cm/sec}^2}{10^{-3} \text{ rms cm/sec}^2}$$

Velocity Decibels = vdB =

$$20 \log_{10} \frac{\text{measured velocity in rms cm/sec}}{10^{-6} \text{ rms cm/sec}}$$

$$adB = (vdB - 44) + 20 \log_{10} f$$

where f = frequency in Hz

Table 2-11. Acceleration Decibels (adB) Relative to g

adB	rms cm/sec^2	rms g	peak sinusoidal g
0	10^{-3}	1.02×10^{-6}	1.44×10^{-6}
20	10^{-2}	1.02×10^{-5}	1.44×10^{-5}
40	10^{-1}	1.02×10^{-4}	1.44×10^{-4}
60	1	1.02×10^{-3}	1.44×10^{-3}
80	10	1.02×10^{-2}	1.44×10^{-2}
100	100	1.02×10^{-1}	1.44×10^{-1}
120	1000	1.02	1.44

Table 2-9. Representative Quantities in Air

	Sound Pressure p (μbar)	Sound Pressure p (N/m^2)	Intensity I (W/m^2)	Particle velocity v (m/s)	Sound pressure level L (dB)
Above threshold of pain	2000	200	100	5×10^{-1}	140
	200	20	1	5×10^{-2}	120
	20	2	10^{-2}	5×10^{-3}	100
	2	2×10^{-1}	10^{-4}	5×10^{-4}	80
	2×10^{-1}	2×10^{-2}	10^{-6}	5×10^{-5}	60
	2×10^{-2}	2×10^{-3}	10^{-8}	5×10^{-6}	40
	2×10^{-3}	2×10^{-4}	10^{-10}	5×10^{-7}	20
Reference point (approximately the threshold of hearing)	2×10^{-4}	2×10^{-5}	10^{-12}	5×10^{-8}	0

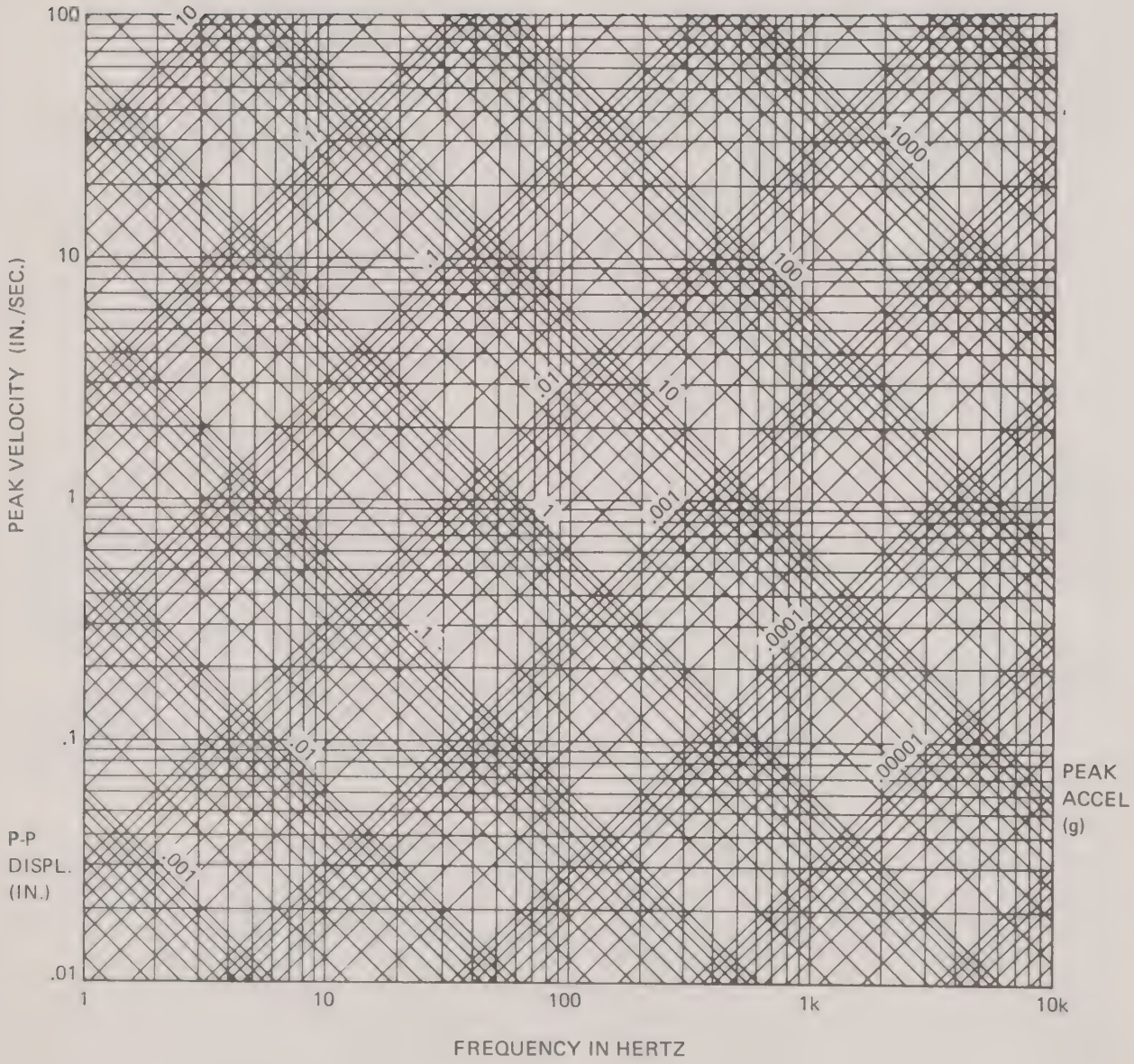


Figure 2-21. Vibration Nomograph

SECTION III

CONCEPT AND THEORY OF OPERATION

3.1 CONCEPT OF OPERATION

The Model SD330 Spectrascope – Real Time Analyzer operates as a frequency-tuned bandpass filter to convert the input signal from the time domain to the frequency domain in real time. (See Figure 3-1.)

The Spectrascope employs a digital time compression process to prepare the input signal for Fourier analysis. The time compressed signal is frequency analyzed using 250 synthesized filter locations that are tuned by a built-in sweep oscillator. Frequency (X-axis) and spectrum (Y-axis) data can be displayed on the built-in oscilloscope and are made available at rear-chassis connectors for external monitoring or X-Y recording.

The internal display presents a spectrum in terms of linear frequency versus either linear or logarithmic amplitude as selected. However, both linear and logarithmic frequency outputs are made available for external monitoring.

The time domain input signal can be displayed on the internal oscilloscope to allow observation of gross data values, bias voltages, possible limiting, etc.

The Spectrascope also provides for ensemble averaging of successive spectra. In this mode, the average of a selected number of spectra can be observed or, a running (exponential) average can be maintained and displayed.

The Spectrascope also has the ability to capture and hold the peak values for the 250 filter locations.

An integral calibration circuit enables calibration of oscilloscope and X-Y recorder on all analysis frequency ranges. A manually-controlled locater (digital thumbswitch) and an intensified marker are available for identifying the exact frequency of any spectrum line on display.

3.2 FUNCTIONAL BLOCK DIAGRAM DESCRIPTION

The following paragraphs provide a functional description of the SD330 Spectrascope. A block diagram supports the text. (See Figure 3-2, Sheets 1 and 2 at end of Paragraph 3.2.9.) The functional description provides a good, general operating knowledge of this versatile instrument in its various modes.

Spectrascope circuits can be divided into nine functional groups as depicted in Figure 3-2, Sheet 2. Each of these groups is described separately.

3.2.1 Input Conditioning (See Figure 3-2, Sheet 2.)

In the normal (OPER) mode of the analyzer, the input conditioning circuits normalize the data input signal, limit its bandwidth and supply it to the time compression circuits. A normalized but unfiltered version of the data input signal is available for time domain display.

In the spectrum (Y-axis) and frequency (X-axis) calibration modes (CAL SPECT and CAL FREQ), the conditioning circuits normalize the selected calibration signal. The Y-axis calibration signal (CAL SPECT) takes the place of the input data signal and is supplied via the input attenuator to the time compression circuits. Suitable outputs for Y-axis calibration of oscilloscope and plotter are provided with the INPUT RANGE/CAL push buttons. When the X-axis calibration signal (CAL FREQ) is selected, these same push buttons are used to provide suitable X-axis calibration points.

In the signal conditioning circuits, filter bandwidth and upper frequency limit are controlled by the ANALYSIS RANGE selector on the front panel. The INPUT meter, also on the front panel, indicates peak level of the filtered signal. The meter circuit is enabled to cover the wide frequency range of the analyzer through provision of three different peak-detection time constants via the ANALYSIS RANGE selector. If input signal level exceeds the selected full-scale range, the input OVERLOAD light comes on.

The ANALYSIS RANGE selector also controls the rate at which the normalized and band-limited signal is sampled in the time compression circuits.

3.2.2 Time Compression

The time compression circuits sample the analog data signal and store the samples in a digital memory which has a storage capacity of 750, 8-bit words. The stored data signal is then read out at a fast rate to produce time compression. The time compressed signal is a replica of the analog signal supplied by the input conditioning circuits. Frequency range of the replica is DC to

1.25 MHz on all analysis frequency ranges. (The upper frequency of the selected analysis range is always translated to 1.25 MHz.)

The time compression circuits sample the amplitude of the conditioned signal at a rate three times the upper limit frequency selected by the ANALYSIS RANGE selector. An analog-to-digital (A-D) converter generates an 8-bit word corresponding to amplitude of each sample. These digital descriptions are placed in a continuously circulating memory. One circulation requires 200 μs. Memory loading is synchronized with circulation so that each new word is placed in memory at the location immediately behind the last word loaded. While it may require hundreds of circulations to fill the memory (a function of sampling rate), the contents are read out in only one circulation. Thus, the entire contents of the memory can be displayed every 200 μs, regardless of the rate at which the data signal is sampled. The speeded-up digital signal is converted back to an analog signal for spectrum analysis.

3.2.3 Analyzer

The analyzer section processes the high-frequency (time compressed) analog signal and produces a d-c voltage corresponding to one spectral point each time the digital memory recirculates. Two hundred and fifty spectral points are obtained in 50 ms, since the circulation period of the memory is 200 μs. The output spectrum is available in either linear smooth or logarithmic smooth form. Also, the waveform in storage in the digital memory is available in analog form for display on an external oscilloscope.

In the analysis process, the DC to 1.25-MHz signal is combined in a balanced modulator with a tuning signal from a sweep oscillator. The oscillator frequency is incremented in 250, 5-kHz steps over the range of 5 MHz to 6.25 MHz every 50 ms. Duration of each step increment (200 μs) equals one circulation period of the digital memory. By combining the 5-MHz to 6.25-MHz oscillator signal with the DC to 1.25-MHz data signal the data signal is up-converted to a 5-MHz intermediate frequency. The presence of a 5-MHz I.F. signal during any oscillator frequency step (synthesized filter location) represents data. Amplitude of the I.F. signal is proportional to magnitude of the data. The data signal is time-weighted by multiplying it with a $(\text{cosine})^2$ wave. This function effectively eliminates side-lobe spectra produced by the effects due to a finite record length in memory. The weighted I.F. signal is passed through a 5-MHz narrow-band filter to an amplifier in which output gain can be controlled.

The weighted, 5-MHz I.F. signal is down-converted by combining it with a 4.8-MHz signal produced by a crystal-controlled oscillator. The 200-kHz difference frequency component is detected and the result is sampled in synchronism with the time weighting signal. The detected signal is sampled during the latter portion of each oscillator step increment. This allows the 5-MHz I.F. filter sufficient response time. The sampled data is in linear step form and can be processed in the averager if desired. The averaged or unaveraged spectrum data is smoothed for display and outputing. A log converter provides a log smooth version which can be selected for display and outputing. An overload indication is provided for any spectrum exceeding full-scale output.

Before the signal is processed in the analyzer section, internally-generated frequency markers can be combined with the data signal. When this is done, 10 equally-spaced frequency markers appear in the spectrum display, as illustrated in Figure 2-2 of Section II. The markers are added to the data signal at the input of the analysis section.

3.2.4 Sweep Oscillator (VCO)

The sweep oscillator is a voltage-controlled oscillator (VCO). It generates the 5-MHz to 6.25-MHz signal that is combined with the DC to 1.25-MHz time compressed data signal to synthesize the 250 filter locations in the analyzer section. The VCO frequency is linearly stepped in 250, 5-kHz increments of 200-μs duration each. The step voltage is generated by a BCD ladder (D-A converter) in the digital control section.

3.2.5 Master Clock

The clock section generates the timing signals that synchronize all internal operations of the Spectrascope. A crystal-controlled oscillator generates a 15-MHz source frequency and a series of digital divider circuits provide the specific clock frequencies required. The clock circuits also determine the data sample rate in the time compression circuits, based on the position of the ANALYSIS RANGE selector. The clock section also generates the signal used in the digital control section to determine the period of the X-axis sweep. Sweep period is 50 ms in the SCOPE SPECT mode for all positions of the ANALYSIS RANGE selector. In SCOPE TIME mode, sweep period is different for each position of the ANALYSIS RANGE selector. In the PLOTTER SWEEP mode, sweep period is 25 sec for all analysis ranges. It is emphasized that the X-axis sweep represents spectrum frequency in the SCOPE SPECT and PLOTTER SWEEP MODES.

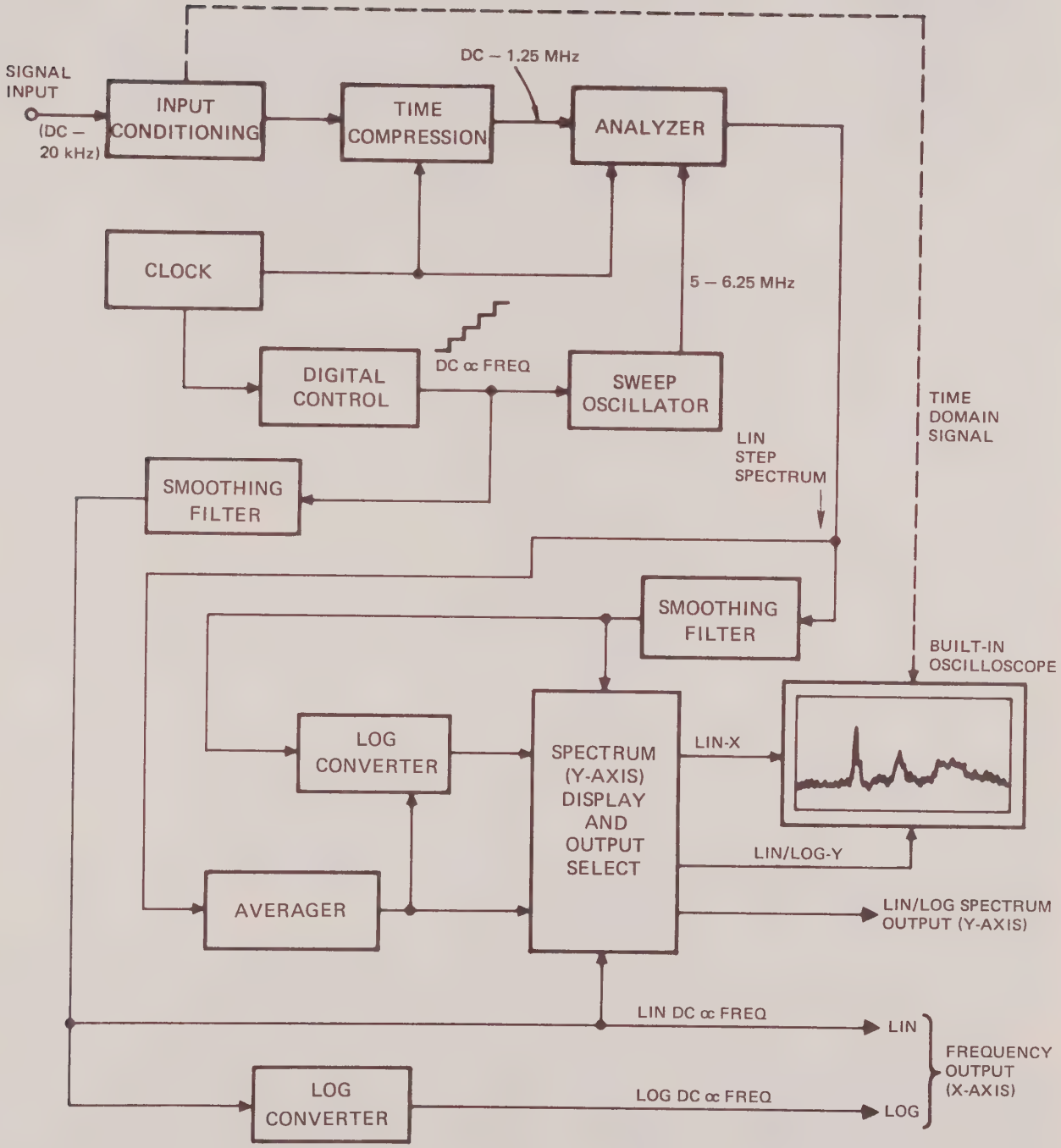


Figure 3-1. Simplified Block Diagram, Spectrascope

3.2.6 Digital Control

The digital control circuits perform synchronization, calibration and display control functions associated with the various operating modes of the Spectrascope. A counter and BCD ladder combination generates the voltages which step the sweep oscillator (VCO) in the SCOPE SPECT and PLOTTER modes and provide the X-axis sweep in all modes. The counter and BCD ladder are controlled by the counter control circuits, the DIGITAL LOCATER thumbswitch and the display control and marker generator circuits.

In the SCOPE SPECT mode, the counter control circuits supply 20-kHz clock pulses to the counter which provides the full count of 1000 in 50 ms. However, counter decoding circuits select only every fourth counter increment for application to the BCD ladder. This results in 250 incremental steps in VCO frequency and X-axis sweep voltage during each 50-ms period. Duration of each increment is 200 μs, which equals one circulation period of the digital memory.

In the SCOPE SPECT mode, an intensified mark (bright spot on the oscilloscope) can be selected and positioned over any one of 250 points on the X-axis. These points correspond to the 250 filter locations. The INTEN MARKS push button is used to select the intensified mark and the DIGITAL LOCATER is used to position the mark. The effect of this control is to momentarily inhibit the counter at a count corresponding to the digital value set on the control. (Inhibiting the counter causes the sweep to pause, thus intensifying that point on the display.) However, the DIGITAL LOCATER thumbswitch increments from 1 to 999 in single-digit steps, and there are 250 filter locations; therefore, an intensified mark will stay over a point (filter location) through 4-digits change of the switch. For X-axis calibration of the display with the FREQ MARKS and the INTEN MARKS selected and the DIGITAL LOCATER set to 000, 10 intensified marks (one on top of each frequency marker) will appear on the Spectrascope as illustrated in Figure 2-2 of Section II.

In the SCOPE TIME mode, the counter control circuits supply pulses to the counter at a frequency 30 times the upper limit frequency determined by the ANALYSIS RANGE selector. Thus, for example, in the 20-kHz range, the frequency to the counter is 600 kHz. To produce an X-axis sweep in this mode, the counter increments the BCD ladder output in 999 steps at the input rate. Table 1-1 in Section I lists the sweep period per graticule division of the Spectrascope in each of the nine positions of the ANALYSIS RANGE selector in SCOPE TIME mode. To obtain sweep period for any position of the ANALYSIS RANGE selector in SCOPE TIME mode, multiply the sweep period per graticule division (from Table 1-1) by 10.

In the SCOPE TIME mode, the trigger for starting the X-axis sweep is provided by the input signal. The signal level at which the trigger occurs is determined by the setting of the TRIGGER LEVEL control on the front panel.

In the CAL SPECT mode, with the SCOPE SPECT mode also selected, the digital control circuits provide a square wave signal at a frequency 3/10 the upper limit of the selected analysis range. This signal is applied to the input conditioning circuits and takes the place of the input signal. The signal is normalized, time compressed, analyzed and displayed to provide calibrated spectrum lines at 30 and 90 percent of the selected analysis range. In the CAL SPECT mode, with the SCOPE TIME mode also selected, square waves are displayed with square wave period and time axis a function of the ANALYSIS RANGE switch position. Square wave periods and time axes are such that the display appears to be the same on all ranges. (Refer to Table 1-1 in Section I for specific data.)

In the PLOTTER SWEEP mode, the counter control circuits supply 40-Hz clock pulses to the counter which increments the BCD ladder output at the 40-Hz rate. This produces 999 incremental steps in VCO frequency and X-axis sweep voltage during a period of 25 sec.

A sweep rate feedback (SRF) circuit is activated in PLOTTER SWEEP mode to slow the X-axis sweep when high rates of change occur in the spectrum (Y-axis) data. The SRF action momentarily inhibits the counter by a time that is proportional to rate of change in spectrum amplitude. Any SRF action during a plotter sweep will increase sweep period beyond the minimum period of 25 sec.

In the MANUAL mode the DIGITAL LOCATER thumbswitch is used to control the input to the BCD ladder. In this mode the ladder output to the VCO and X-axis amplifier is manually adjustable in 999 increments. When in the MANUAL mode, the analyzer acts as a tunable filter, the center frequency of which is manually selected with the DIGITAL LOCATER thumbswitch. The spectrum of the selected analysis range can be tuned to any one of 999 frequency increments across the X-axis.

NOTE

The use of 999 steps (instead of 250) in the MANUAL and PLOTTER SWEEP modes increases display definition.

In the MEMORY TRANS CAPT mode, transients or selected segments of continuous signals can be "captured" and stored in the digital memory for repeated analysis. Moreover, any number of samples up to 750 (memory capacity) can be preselected for "capture" and storage. For this mode the DIGITAL LOCATER thumbswitch and transient capture trigger circuit are used. When this mode is selected, the Spectrascope continues operating in the UPDATE mode, that is, new data samples are being loaded into the digital memory. But when the transient capture circuit senses a signal level corresponding to the setting of the TRIGGER LEVEL control on the front panel, a "capture" signal causes a counter in the display control and marker generator circuits to start counting the sample pulses supplied to the time compression circuits from the clock. When the number of sample pulses counted equals the number selected on the DIGITAL LOCATER (up to 750), the Spectrascope goes into the MEMORY HOLD mode. A setting on the DIGITAL LOCATER greater than 750 is treated as 750. In the HOLD mode, no new data enters memory but the stored data continues to circulate and be read out for repeated analysis.

3.2.7 Display Oscilloscope

The display oscilloscope section presents the data on the internal cathode ray tube (CRT). The section consists of the X-axis and Y-axis amplifiers and the CRT and its operating controls.

In the SCOPE SPECT mode, the oscilloscope displays an analysis of the frequency and amplitude content of the input data signal. The X-axis of the display represents frequency and the Y-axis represents amplitude corresponding to frequency. The display is presented every 50 ms. To accurately locate a particular frequency point, an intensified spot can be selected with the INTEN MARKS push button and positioned with the DIGITAL LOCATER thumbswitch.

In the SCOPE TIME mode, time domain data is displayed. Nine different sweep periods are available in this mode – a different period for each position of the ANALYSIS RANGE selector. (Refer to Table 1-1 in Section I.) In the PLOTTER SWEEP mode, a slow sweep will be observed on the display. Sweep time is 25 seconds plus any additional time required for SRF action. In the MANUAL mode, the display consists of one spot: The X-component represents frequency and the Y-component represents amplitude of the input data signal at that frequency.

Oscilloscope gain and offset controls permit the operator to adjust both axes of the display for calibration and operation. Focus and intensity controls are also provided.

3.2.8 Averager (See Figure 3-2, Sheet 1.)

The averager section of the analyzer includes a 250-word memory capable of storing a digital description of 250 filter locations. The averager allows three distinct modes of operation: START, EXPO AVG, and PEAK HOLD. The START and EXPO AVG modes are spectrum averaging modes. The PEAK HOLD mode stores peak spectrum amplitude data. The AVG push button, when depressed, enables selection of any one of the three modes.

In the START mode, the averager averages a selected number of successive ensembles* on a non-redundant basis, that is, the 750-word memory of the analyzer is allowed time to fill with new data between successive examinations of its contents. When the selected number of ensemble averages has been completed, the process stops automatically and the STOP/STORE indicator lights continuously to signify that the averaged spectrum is calibrated for unity gain with respect to the unaveraged spectrum. Pressing the STOP/STORE push button before the averaging process has been completed will stop the process but the results may not be at unity gain. If the AVG push button is released before the averaging process has been completed, data will be maintained in memory so that when the AVG push button is pressed again, the averaging process will resume from the number of averages attained at the time the AVG push button was released.

The total averaging time in the START mode is the product of the number of averages selected and the memory period of the selected analysis range. For example, if 8 averages are selected on the 500-Hz range (0.5 sec memory period), the total averaging time will be 4 seconds. This information is valid for all but the 10-kHz and 20-kHz analysis ranges. To calculate the total averaging time in either of these two ranges, a memory period of 0.05 sec must be used. Therefore, the total averaging time on either of these ranges with 8 averages selected will be 8 x 0.05 sec = 0.4 sec.

To initiate the averaging process, the AVG push button is depressed, the desired number of averages (up to 512) is next selected with the NUMBER OF AVERAGES push buttons, and the START push button is then pressed. Upon pressing the START push button, the averager

*Ensemble = a sequence of spectrum outputs – one ensemble comprises 250 linear voltage steps; the value of each step is proportional to the spectrum signal amplitude of a synthesized filter location.

memory is erased and the first ensemble is converted to digital form and stored in the averager memory. If only the NUMBER OF AVERAGES 1 push button is pressed, the averager does not accept additional ensembles. The ensemble in memory is read out repeatedly and divided by 1 each time for unity display.

If the NUMBER OF AVERAGES 4 push button is pressed, the averager accepts a second, third, and fourth ensemble and sequentially adds their digital values to the first ensemble stored in memory. However, when the second ensemble is added to the first, the memory is read out and the contents divided by 2; when the third ensemble is added to the sum of the first two the memory is read out and the contents divided by 4; when the fourth ensemble (the number of averages selected in this example) is added to the sum of the first three the memory is read out and the contents divided by 4. The data is now calibrated and the readout continues with a divisor of 4. At this point the STOP/START indicator comes on and continuously lights to signify that the data is calibrated and that the selected number of averages has been attained. It is emphasized that the data is not normalized to unity gain for display until the STOP/STORE indicator comes on.

In the START mode, no new data is accepted by the averager once the selected number of averages has been reached. The maximum number of averages is performed when the NUMBER OF AVERAGES 16 and MULT X32 push buttons are pressed. In this case, the divisor changes (in binary increments) from 1 to 512 as the sum of the values of successive ensembles accumulates. When 512 ensembles have been summed, the divisor is 512 and the data is calibrated.

If the number of averages is changed after the START mode has been selected, the averager memory is erased and the averaging process restarts, that is, the action is the same as when the START push button was initially pressed.

Also if, after an averaging process is complete, it is desired to view or record unaveraged data without disturbing the averaged data, the AVG push button can be released to permit viewing or recording of the unaveraged data, and pressed again when ready to again view or record the averaged data.

An exponential averaging mode is selected with the EXPO AVG push button. But a valid EXPO AVG mode can be selected only after a normal averaging process has been initiated with the START push button or, by changing the desired number of averages while the EXPO AVG mode is selected. If EXPO AVG mode is selected without first selecting the START mode, the averaging process will commence with whatever data is in memory, even if it is start-up transient data. If the EXPO AVG mode is selected before the START mode completes the selected number of averages, the averaging process will continue until the selected number of averages is reached, at which time the averager will automatically switch to the EXPO AVG mode. When in the EXPO AVG mode, the STOP/STORE indicator flashes. The mode can be terminated by pressing the STOP/STORE push button. If, while in the EXPO AVG mode, the desired number of averages is changed, the averager will perform a new and valid averaging process, that is, the memory will be erased, the new number of averages will be performed and the exponential averaging mode will commence (STOP/START indicator flashes) upon reaching the new number of averages.

In the EXPO AVG mode, the averager continues to accept a new ensemble every analyzer memory period after the selected number of averages has been reached. In this mode, the sumset of ensemble data, S, in memory is added to the new ensemble, X, to produce sum X + S. Then, the average of the memory sumset, $\frac{S}{N} = A$, is subtracted from this sum so that X + S – A becomes the value of the new sumset to be loaded into memory. When this sumset (X + S – A) is divided by the selected number of averages N, the new average is available in accordance with the following recursion formula:

$$\text{Sumset} = S$$

$$\text{For } i^{th} \text{ iteration Sumset} = S_i$$

$$A_i = \text{Average for } i^{th} \text{ iteration} = \frac{S_i}{N}$$

$$S_i + 1 = S_i + X_i - A_i$$

$$\frac{S_i + 1}{N} = \frac{S_i}{N} + \frac{X_i - A_i}{N}$$

$$\underset{\text{New Avg}}{\frac{S_i + 1}{N}} = \underset{\text{Old Avg}}{\frac{S_i}{N}} + \underset{\text{Correction}}{\frac{X_i - A_i}{N}}$$

$$A_i + 1 = A_i + \frac{X_i - A_i}{N}$$

In this mode, the old average is corrected every time new data is available, that is, once each period of the 750-word memory. Each new average in turn becomes the old average for the next correction. The recursion procedure makes the averaging process of the EXPO AVG mode equivalent to exponential averaging – as determined

by R-C averaging in a continuous system. The time constant 'T' for the digital averaging in the EXPO AVG mode is given as:

T ∝ selected number of averages x period of the 750-word memory.

NOTE

A memory period of 50 ms must be used for calculating T when either the 10-kHz or 20-kHz range is selected.

Table 3-1 gives the equivalent R-C averaging time constant for 2, 4, 8, 16, 32 and 64 averages in the EXPO AVG mode. It can thus be seen that for large values of N, there is negligible difference between the two time constants.

Table 3-1. Comparison of Time Constants

No. of Averages (N)	Equivalent R-C Averaging Time Constant
2	1.4 x T*
4	1.15 x T*
8	1.07 x T*
16	1.03 x T*
32	1.015 x T*
64	1.007 x T*

*T ∝ selected number of averages x period of the 750-word memory. (Refer to NOTE above.)

In the EXPO AVG mode, the averaged data is valid when the STOP/STORE indicator is flashing because the averaged data is continuously calibrated. If, while in the EXPO AVG mode, it is desired to view or record unaveraged data without disturbing the averaged data, the mode can be terminated by pressing the STOP/STORE push button. When this is done, the last completed sumset is held in memory and the STOP/STORE indicator lights continuously. Then, by releasing the AVG push button, unaveraged data can be viewed or recorded. The averaged data held in memory can be subsequently reselected for viewing or recording by again pressing the AVG push button.

In the PEAK HOLD mode, the averager memory stores the peak spectrum values for each of the 250 filter locations. Upon pressing the PEAK HOLD push button, the averager memory is erased, a divisor of 1 is selected and the next ensemble is entered. (The NUMBER OF AVERAGES and MULT X32 push buttons are not active.) Upon receipt of each subsequent ensemble, each of the 250 filter locations in memory is updated, but only in a positive direction. That is, the data in a particular location is changed only if the new data value for that location exceeds the previous value. In this mode, the averager output (peak spectrum data) is updated every period of the 750-word memory.

When in the PEAK HOLD mode, the STOP/STORE indicator flashes. Pressing the STOP/STORE push button terminates the mode.

If the PEAK HOLD push button remains depressed when the AVG push button is released, the averager will continue in the PEAK HOLD mode, but the data will not be displayed again until the AVG push button is again pressed.

3.2.9 Power Supplies

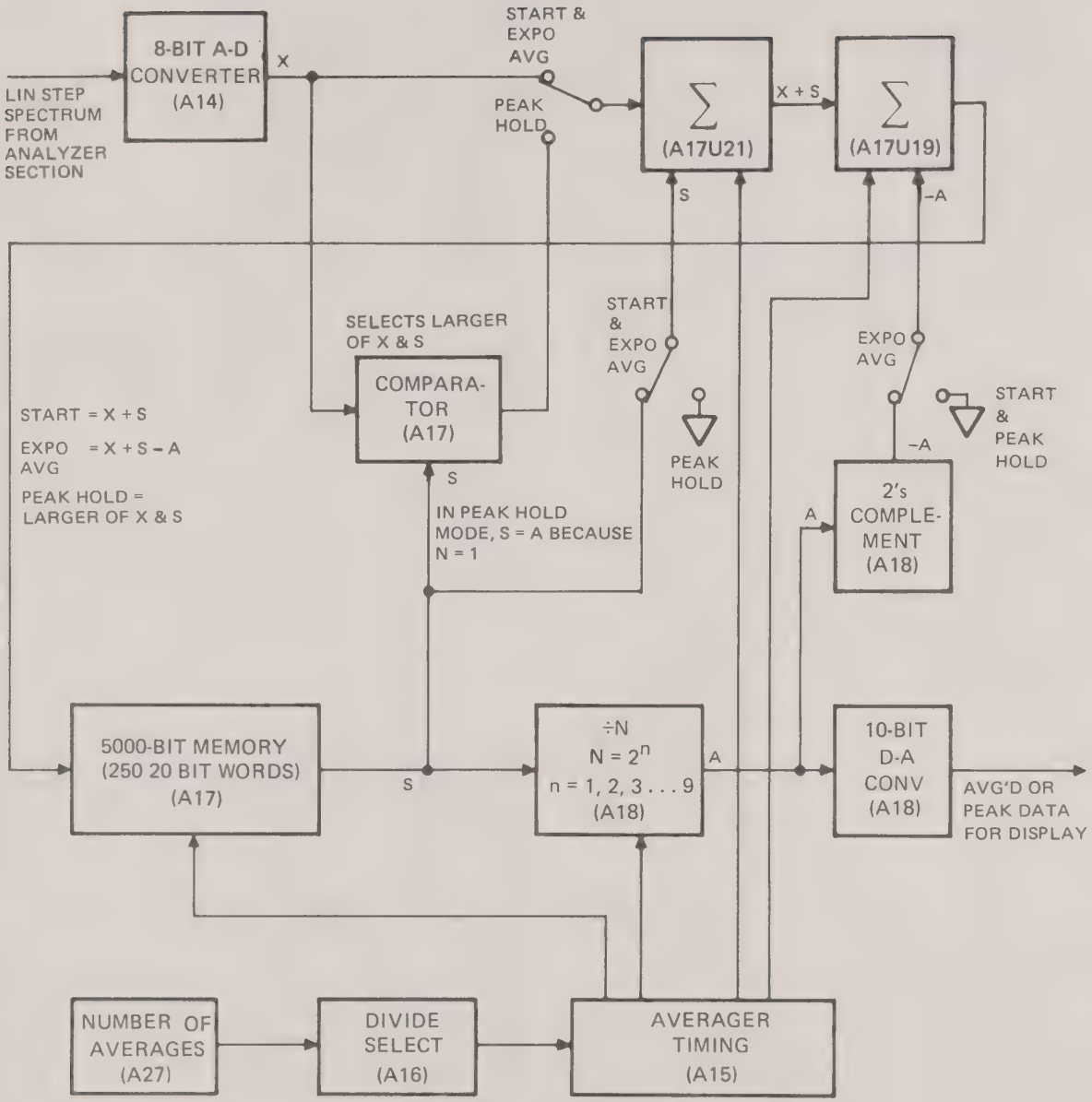
The Spectrascope contains a low-voltage power supply and a high-voltage supply. Supply input voltages are provided from a common power transformer which also furnishes filament voltage for the CRT. The transformer primary circuit is fused (F2, rear panel) and equipped with a sliding switch (S3, rear panel) to permit operation from either a 115V or 230V power source.

The low-voltage power supply provides regulated output voltages of +15, −15, −10 and +5. The +5V supply is provided with an over-voltage protector of which a fuse (F1, rear panel) is a part.

WARNING

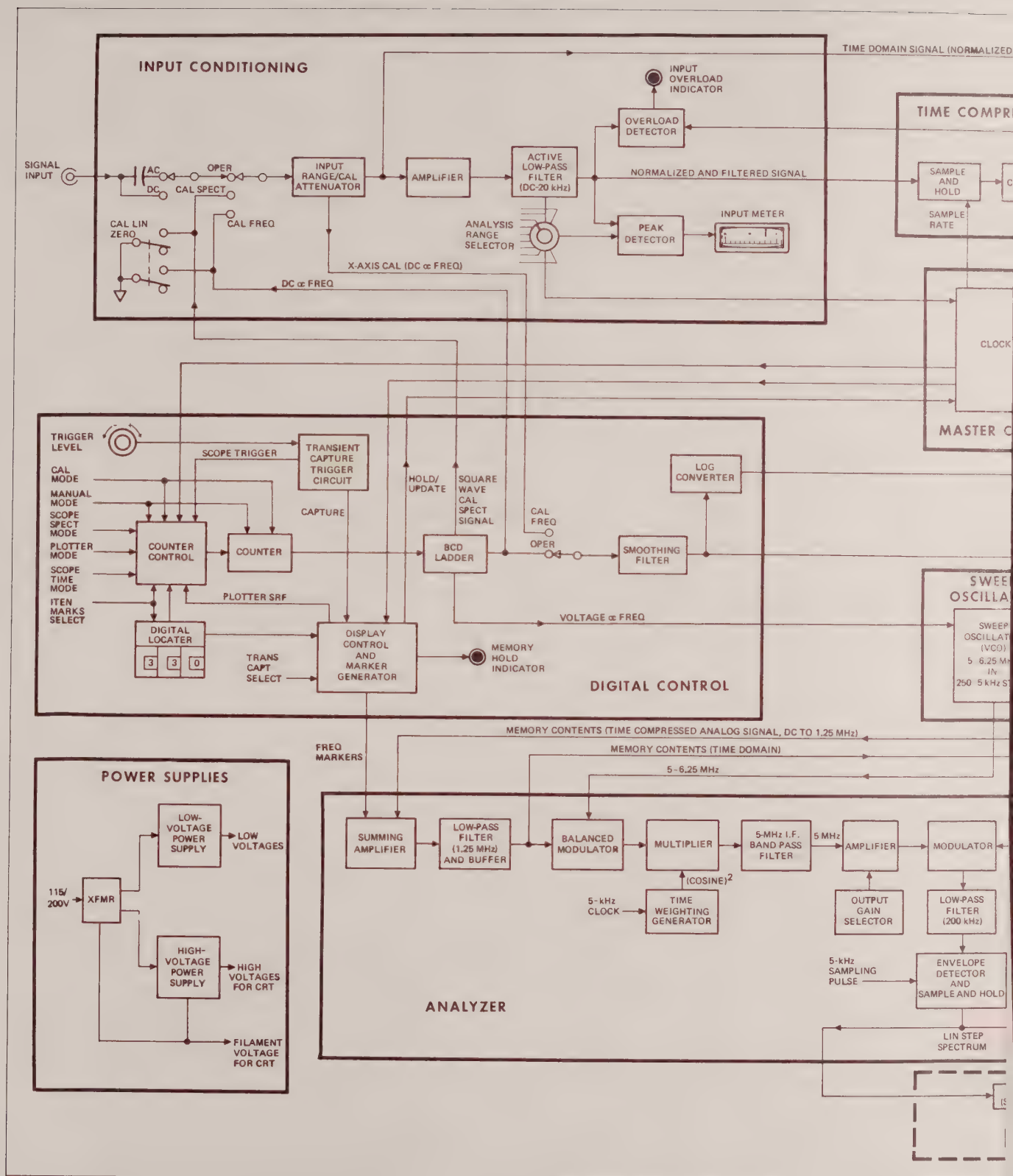
The high-voltage power supply produces voltages dangerous to life. The highest output is approximately 1400V.

The high-voltage power supply produces the operating potentials for the CRT.



AVERAGER

Figure 3-2 (Sheet 1). Functional Block Diagram of Spectrascope


INPUT CONDITIONING
TIME DOMAIN SIGNAL (NORMALIZED
INPUT OVERLOAD INDICATOR
OVERLOAD DETECTOR
TIME COMPR
SIGNAL INPUT
AC
DC
OPER
CAL SPECT
INPUT RANGE/CAL ATTENUATOR
AMPLIFIER
ACTIVE LOW-PASS FILTER (DC-20 kHz)
NORMALIZED AND FILTERED SIGNAL
SAMPLE AND HOLD
SAMPLE RATE
CAL LIN ZERO
CAL FREQ
ANALYSIS RANGE SELECTOR
PEAK DETECTOR
INPUT METER
X-AXIS CAL (DC ∝ FREQ)
DC ∝ FREQ
CLOCK
MASTER C
TRIGGER LEVEL
SCOPE TRIGGER
TRANSIENT CAPTURE TRIGGER CIRCUIT
CAL MODE
MANUAL MODE
SCOPE SPECT MODE
PLOTTER MODE
SCOPE TIME MODE
ITEN MARKS SELECT
CAPTURE
HOLD/ UPDATE
SQUARE WAVE CAL SPECT SIGNAL
LOG CONVERTER
CAL FREQ
OPER
COUNTER CONTROL
COUNTER
BCD LADDER
SMOOTHING FILTER
PLOTTER SRF
VOLTAGE ∝ FREQ
SWEE
OSCILLA
SWEEP OSCILLAT (VCO)
5 6.25 M
IN
250 5 kHz ST
DIGITAL LOCATER
3 3 0
TRANS CAPT SELECT
DISPLAY CONTROL AND MARKER GENERATOR
MEMORY HOLD INDICATOR
DIGITAL CONTROL
MEMORY CONTENTS (TIME COMPRESSED ANALOG SIGNAL, DC TO 1.25 MHz)
FREQ MARKERS
MEMORY CONTENTS (TIME DOMAIN)
5-6.25 MHz
POWER SUPPLIES
LOW-VOLTAGE POWER SUPPLY
LOW VOLTAGES
115/ 200V
XFMR
HIGH-VOLTAGE POWER SUPPLY
HIGH VOLTAGES FOR CRT
FILAMENT VOLTAGE FOR CRT
SUMMING AMPLIFIER
LOW-PASS FILTER (1.25 MHz) AND BUFFER
BALANCED MODULATOR
MULTIPLIER
5-MHz I.F. BAND PASS FILTER
5 MHz
AMPLIFIER
MODULATOR
(COSINE)2
5-kHz CLOCK
TIME WEIGHTING GENERATOR
OUTPUT GAIN SELECTOR
LOW-PASS FILTER (200 kHz)
5-kHz SAMPLING PULSE
ENVELOPE DETECTOR AND SAMPLE AND HOLD
ANALYZER
LIN STEP SPECTRUM

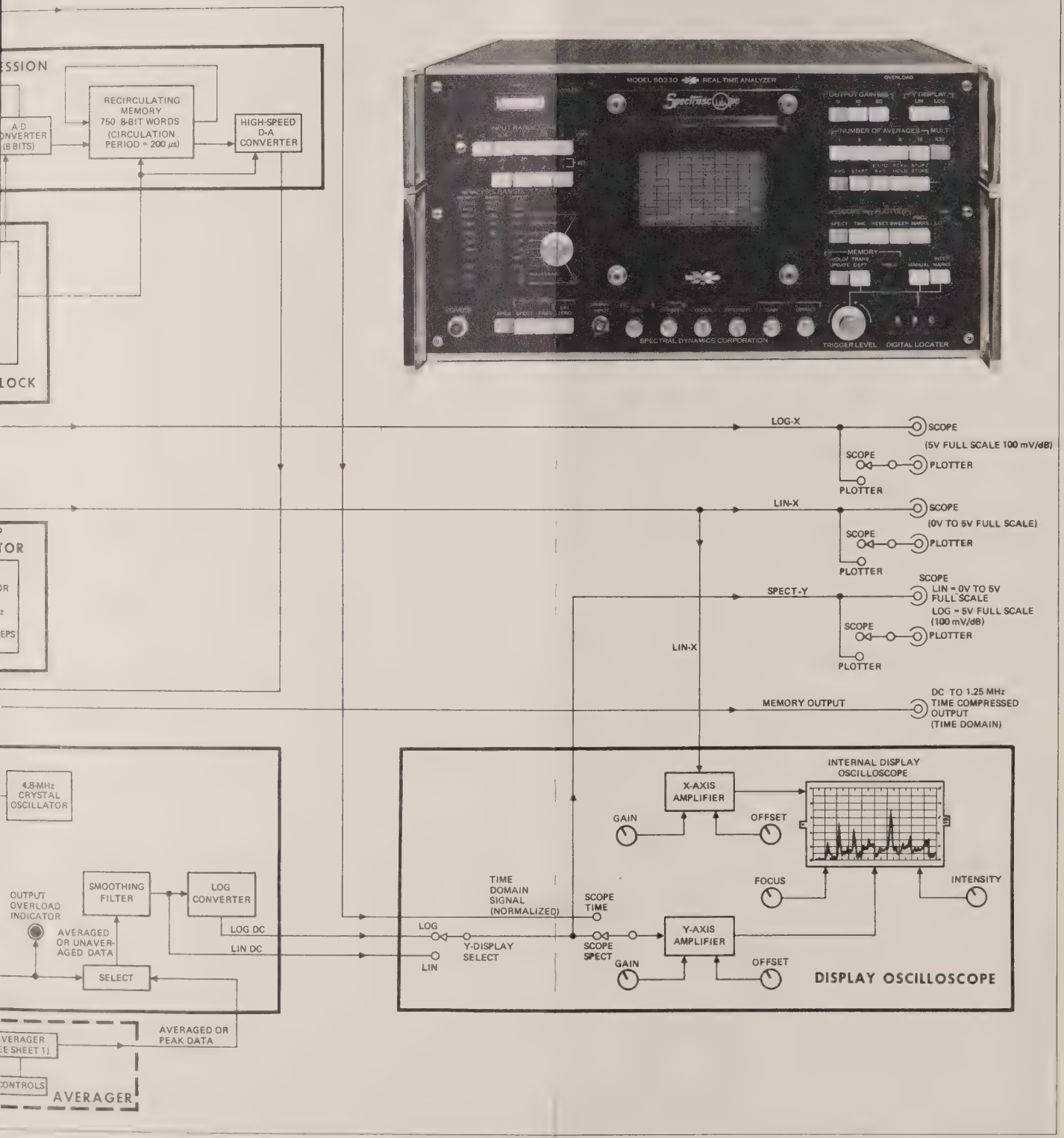


Figure 3-2 (Sheet 2). Functional Block Diagram of Spectrascope

SECTION IV

CALIBRATION

4.1 GENERAL

This section contains instructions for calibrating the Spectrascope, except for circuit cards A14 and A18, and the A-D conversion circuits of circuit card A2. Calibration of cards A14 and A18 and the A-D conversion circuits on card A2 requires the Model SD35-6 D/A—A/D Calibration Fixture, available from Spectral Dynamics Corporation. The calibration procedures for the three cards are included with the calibration fixture. Calibration data for other circuits on card A2 is included in this section.

When performing the procedures contained in this section, adjustment controls on circuit cards A14 and A18 should not be disturbed and, on circuit card A2, only specified controls should be adjusted.

Before attempting to calibrate the instrument, the technician should be familiar with the contents of Sections I and III of this manual. During calibration, access to all controls and test points on the circuit boards is enabled by use of an extender card. An unshielded extender card (A9) is supplied as an integral part of the Spectrascope. However, a shielded extender is required for cards on which high frequencies exist. This procedure specifies use of a shielded extender (Model SD35-4) where applicable. A circuit card should be extended only when specified by the procedure.

Throughout this section, adjustment controls and test points are referred to by their alphanumeric designators, preceded by the designator of the circuit card. For example, A32R11 identifies a control located on circuit card A32. The adjustment controls and test points can be found by observing markings on the circuit cards and by referring to component layout drawings included with the schematic drawings in the rear of this manual. Figure 4-1 shows locations of the circuit cards, extender card and power supplies in the instrument.

Table 4-1 lists the test equipment required for calibrating the SD330. Test equipment with equal or superior performance characteristics can be substituted.

Table 4-1. Test Equipment Required

Name	Model No.	Manufacturer
AC Voltmeter	3400A	Hewlett-Packard
Digital Voltmeter	3440A	Hewlett-Packard
D/A-A/D Calibration Fixture	SD35-6	Spectral Dynamics
Oscilloscope	454	Tektronix
High Frequency Probe	010-0212-00	Tektronix
Oscillator	4200	Krohn-Hite
Frequency Counter	1191	General Radio
Shielded Extender Card	SD35-4	Spectral Dynamics
Volt-Ohmmeter	269	Simpson

NOTE

To properly calibrate the instrument, all procedures contained in this section must be performed and all steps must be performed in the sequence given.

4.2 CALIBRATION PROCEDURE

The calibration procedure can be performed successfully only when the instrument is capable of full operation. Thus, an instrument not fully operative must be restored to full operation before commencing the calibration procedure.

SECTION IV

CALIBRATION

4.1 GENERAL

This section contains instructions for calibrating the Spectrascope, except for circuit cards A14 and A18, and the A-D conversion circuits of circuit card A2. Calibration of cards A14 and A18 and the A-D conversion circuits on card A2 requires the Model SD35-6 D/A—A/D Calibration Fixture, available from Spectral Dynamics Corporation. The calibration procedures for the three cards are included with the calibration fixture. Calibration data for other circuits on card A2 is included in this section.

When performing the procedures contained in this section, adjustment controls on circuit cards A14 and A18 should not be disturbed and, on circuit card A2, only specified controls should be adjusted.

Before attempting to calibrate the instrument, the technician should be familiar with the contents of Sections I and III of this manual. During calibration, access to all controls and test points on the circuit boards is enabled by use of an extender card. An unshielded extender card (A9) is supplied as an integral part of the Spectrascope. However, a shielded extender is required for cards on which high frequencies exist. This procedure specifies use of a shielded extender (Model SD35-4) where applicable. A circuit card should be extended only when specified by the procedure.

Throughout this section, adjustment controls and test points are referred to by their alphanumeric designators, preceded by the designator of the circuit card. For example, A32R11 identifies a control located on circuit card A32. The adjustment controls and test points can be found by observing markings on the circuit cards and by referring to component layout drawings included with the schematic drawings in the rear of this manual. Figure 4-1 shows locations of the circuit cards, extender card and power supplies in the instrument.

Table 4-1 lists the test equipment required for calibrating the SD330. Test equipment with equal or superior performance characteristics can be substituted.

Table 4-1. Test Equipment Required

Name	Model No.	Manufacturer
AC Voltmeter	3400A	Hewlett-Packard
Digital Voltmeter	3440A	Hewlett-Packard
D/A-A/D Calibration Fixture	SD35-6	Spectral Dynamics
Oscilloscope	454	Tektronix
High Frequency Probe	010-0212-00	Tektronix
Oscillator	4200	Krohn-Hite
Frequency Counter	1191	General Radio
Shielded Extender Card	SD35-4	Spectral Dynamics
Volt-Ohmmeter	269	Simpson

NOTE

To properly calibrate the instrument, all procedures contained in this section must be performed and all steps must be performed in the sequence given.

4.2 CALIBRATION PROCEDURE

The calibration procedure can be performed successfully only when the instrument is capable of full operation. Thus, an instrument not fully operative must be restored to full operation before commencing the calibration procedure.

WARNING

Voltages dangerous to life are present in the Spectrascope when the instrument is energized. Always remove power from the instrument when removing or installing circuit cards, extender card or other assembly.

4.2.1 Preliminary Procedure

a. Remove the top cover from the instrument.

NOTE

If the Model SD35-6 D/A-A/D Calibration fixture is not available, do not perform Step b. below.

b. Remove High-Speed A-D Converter A2, Averager A-D Converter A14* and Averager D-A Converter A18*.

c. Energize the instrument and allow at least 10 minutes for warmup.

NOTE

The following step can be performed during instrument warmup time.

d. Calibrate the cards removed in Step b. above by installing in the Model SD35-6 D/A-A/D Calibration Fixture and using the calibration procedures included with the fixture.

e. Deenergize the instrument and reinstall the cards removed in Step b. above. Energize the instrument and proceed with Paragraph 4.2.2.

4.2.2 Low-Voltage Power Supply (A19)

a. Connect DVM to A19TP1 and adjust A19R12 for 15.00V (14.98V to 15.02V).

b. Connect DVM to A19TP2 and adjust A19R15 for -15.00V (-14.98V to -15.02V).

*If applicable to the instrument.

NOTE

Use of the extender in the following steps avoids the inconvenience of removing the instrument bottom cover.

c. Remove card A8 from instrument.

d. Install extender in the receptacle for card A8.

e. Connect DVM to Pin 5 (+5V) on top of extender and adjust A19R7 for 5.00V (4.98V to 5.02V).

f. Connect DVM to Pin 10 (-10V) on top of extender and observe that voltage is -10V to -11V.

g. Remove extender and return card A8 to its receptacle.

4.2.3 High-Voltage Power Supply (A32)

WARNING

Voltages dangerous to life are generated by the High-Voltage Power Supply. When testing the high voltage supply, always remove power from instrument before connecting and disconnecting test equipment.

a. Connect DVM to A32TP3 and adjust A32R11 for 180V (175V to 185V).

b. Connect DVM to A32TP2 and observe that voltage is 120V (110V to 130V).

c. Set a Simpson 269 Voltmeter (or equivalent) to the 1600V range and connect to A32TP1 or to A32E6 and observe that voltage is -1300V (-1230V to -1370V).

4.2.4 Circuit Cards A1, A10, A11, A12 and A13.

a. Set the front-panel controls as follows:

- Press INPUT RANGE/CAL .1 Vrms push button and release 1, 2, 3 and 4 dB push buttons.
- AC/DC switch to AC
- ANALYSIS RANGE selector to 2K
- Press OPER push button
- Press OUTPUT GAIN (dB) 0 push button
- Press Y DISPLAY LOG push button

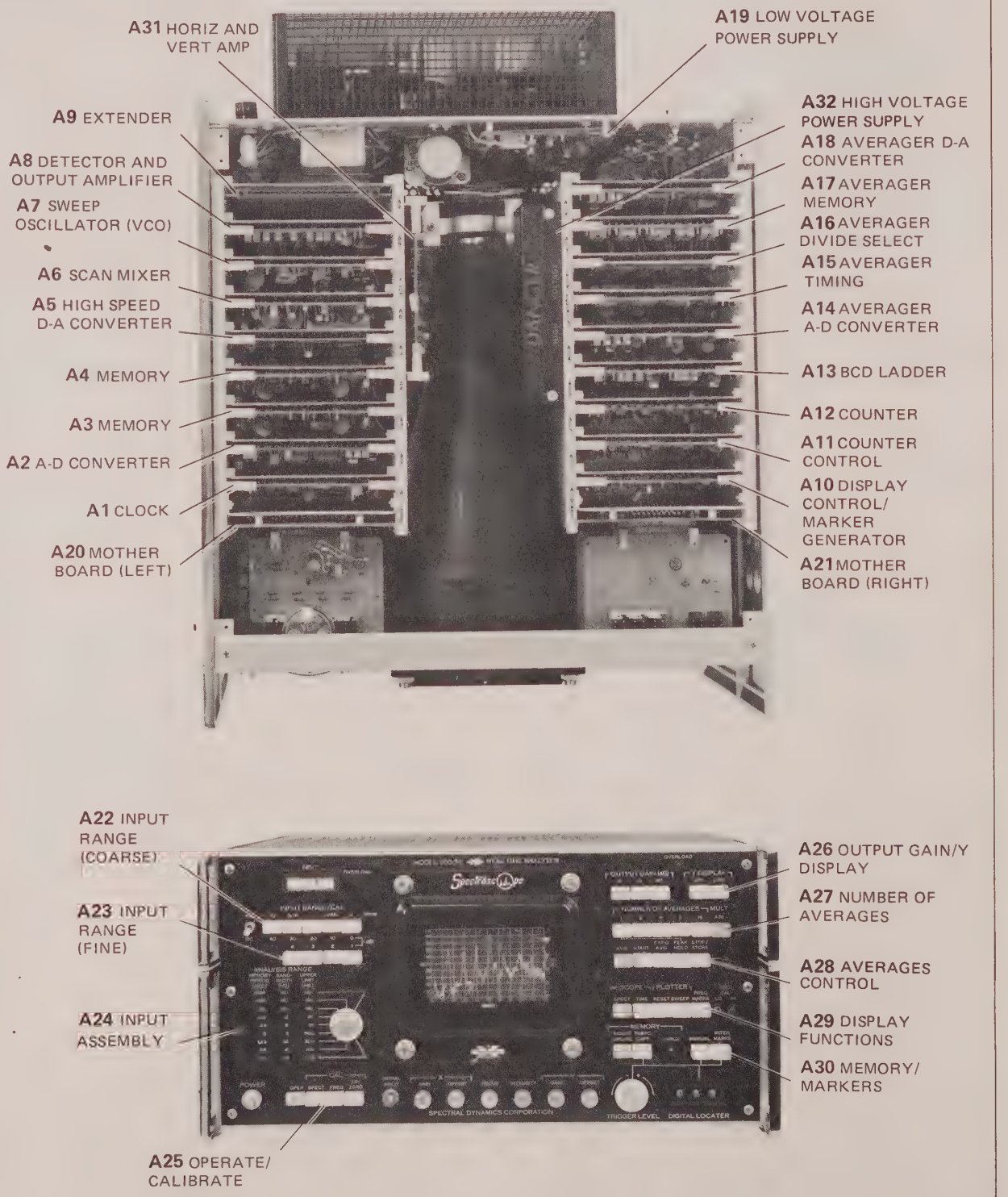


Figure 4-1. Location of Major Assemblies

- Release NUMBER OF AVERAGES push buttons
- Release AVG and associated push buttons
- Press SCOPE SPECT push button
- Release FREQ MARKS push button
- Release MEMORY HOLD/UPDATE push button to activate UPDATE mode (HOLD indicator is not lit).
- Press MANUAL push button
- Release INTEN MARKS push button
- TRIGGER LEVEL control fully CW
- DIGITAL LOCATER to 000

b. Extend card A1, connect counter to A1TP9 and adjust A1C1 for ~~3.74500~~ MHz (3.744990 MHz to ~~3.~~745010 MHz). Remove extender and return card A1 to its receptacle.

c. Extend card A13, connect DVM to A13TP1 and adjust A13R30 for 0 mV (–0.2 mV to +0.2 mV). Leave DVM connected to A13TP1 for Steps d. thru f. below.

d. Set DIGITAL LOCATER to 900 and adjust A13R28 for 4.500V (4.499V to 4.501V).

e. Set DIGITAL LOCATER to 090 and adjust A13R22 for 450 mV (449.8 mV to 450.2 mV).

f. Set DIGITAL LOCATER to 009 and adjust A13R15 for 45 mV (44.8 mV to 45.2 mV).

g. Consecutively set the DIGITAL LOCATER to the numerals listed below and observe that the voltage at A13TP1 agrees with the value specified for each setting.

DIGITAL LOCATER SETTING	VOLTAGE AT A13TP1
007	35 mV (33 mV to 37 mV)
070	350 mV (348 mV to 352 mV)
700	3.500V (3.497V to 3.503V)

h. Connect DVM to A13TP2, press CAL FREQ and INPUT RANGE/CAL 10 Vrms push buttons and adjust A13R35 for 50 mV (49.8 mV to 50.2 mV). Press INPUT RANGE/CAL .1 Vrms push button and adjust A13R31 for 5.000V (4.999V to 5.001V).

i. Press OPER push button.

j. Remove extender and return card A13 to its receptacle.

4.2.5 Circuit Card A8

a. Remove card A18 from instrument.

b. Extend card A8.

c. Connect a temporary jumper wire between A8TP6 and A8TP8 and adjust A8R71 fully CW.

d. Press AVG push button and INPUT RANGE/CAL .1 Vrms push button.

e. Connect DVM to A8TP7, set DIGITAL LOCATER to 010, press OPER and MANUAL push buttons and adjust A8R63 for 1.000V (990 mV to 1.010V). Leave DVM connected to A8TP7 until procedure instructs removal.

f. Set DIGITAL LOCATER to 999 and adjust A8R67 for 5.000V (4.990V to 5.010V).

g. Repeat Steps e. and f. above until voltage for each step remains within specified limits.

h. Set DIGITAL LOCATER to 003 and adjust A8R53 for –20 mV (–40 mV to 0 mV).

i. Repeat Steps e. and h. above until interaction ceases.

j. Repeat Steps e. through h. above until interactions cease.

k. Disconnect DVM from A8TP7 and connect to A8TP9, then repeat Steps e. thru h. above but make the following substitutions:

1) In Step e., adjust A8R90.

2) In Step f., adjust A8R94.

3) In Step h., adjust A8R81.

l. Remove jumper wire connected in Step c. above.

m. Remove extender and return cards A8 and A18 to their respective receptacles.

4.2.6 Circuit Cards A2, A22, A23

a. Install a shorting plug on SIGNAL INPUT connector on front panel.

b. Connect DVM to A22TP1 and adjust A22R14 for 0 mV (–0.02 mV to +0.02 mV)

c. Ensure AC/DC switch on front panel is in AC position.

d. Extend card A2, connect DVM to A2TP9 and record voltage.

e. Press the INPUT RANGE/CAL .1 push button and the 3 and 4 dB push buttons (for 7 dB). Observe that voltage at A2TP9 is within 1 mV of the value recorded in Step d. above. If difference is greater than 1 mV, perform fine adjustment with A22R14 until voltage at A2TP9 does not change more than 1 mV as the 3 and 4 dB push buttons are released (for 0 dB) and pressed (for 7 dB). Upon successful completion of this step, leave the 3 and 4 dB push buttons out (for 0 dB). Leave DVM connected to A2TP9 for Steps f. and g. below.

f. Set ANALYSIS RANGE selector to 100 (Hz) position and adjust A23R23 for voltage recorded in Step d. above, ±0.2 mV.

g. Set ANALYSIS RANGE selector to 25 (Hz) position and adjust A23R22 for voltage recorded in Step d. above, ±0.2 mV.

h. Remove shorting plug installed in Step a. above and apply a 500-Hz (450 Hz to 550 Hz) signal to the SIGNAL INPUT connector at a level of 100 mV rms (99 mV to 101 mV).

i. Set ANALYSIS RANGE selector to 2K position, connect oscilloscope probe to A2TP9 and adjust A23R19 for 4.90V p-p (4.85V to 4.95V p-p).

j. Remove extender and return card A2 to its receptacle.

4.2.7 Circuit Card A7 (VCO)

a. Release MANUAL push button. Extend card A7 on shielded extender, connect oscilloscope probe to A7E2 and adjust A7L6 for approximately 8V p-p non-linear ramp.

b. Connect DVM between A7TP1 and A7TP2 and adjust A7R8 for 75 mV dc (74.95 mV to 75.05 mV).

c. Press FREQ MARKS and INTEN MARKS push buttons and set DIGITAL LOCATER to 000. Adjust FREQ CAL LO and HI controls via front panel so that intensity spot appears on top of each of the 10 frequency markers. (The LO adjuster sets the starting point of the sweep; the HI adjuster determines the spread and distance between the markers.)

d. Release FREQ MARKS push button and press CAL SPECT push button. Intensity spot should appear on top of the 30-percent and 90-percent spectrum lines.

e. Press MANUAL and OPER push buttons, connect frequency counter to the junction of A7U14 Pin 2 and A7R75 and adjust FREQ CAL LO control for 5.000 MHz (4.999 MHz to 5.001 MHz). Set DIGITAL LOCATER to 999 and adjust FREQ CAL HI control for 6.249 MHz (6.248 MHz to 6.250 MHz).

f. Release MANUAL push button, press FREQ MARKS push button, set DIGITAL LOCATER to 000 and adjust A7R2 so that an intensity spot appears on top of each frequency mark.

g. Press CAL SPECT and Y DISPLAY LIN push buttons. Release FREQ MARKS push button. Press MANUAL push button. Note that a spot appears at 30 percent of the X-axis display. Adjust FREQ CAL LO control for peak value of spot. Release MANUAL push button. The peak value of the spectrum line at 30 percent of the X-axis display should be the same as peak value of the spot. If not the same, press MANUAL push button and adjust A26R1 to cause the spot to appear at the peak level of the 30-percent spectrum line. Release MANUAL push button. Press FREQ MARKS and Y DISPLAY LOG push buttons.

h. Apply a ground to Pin 16 of the connector on card A7 and adjust A7R15 so that the intensity spots appear on top of the frequency marks. Observe that calibration spectrum lines appear at 20-percent and 80-percent points of the display.

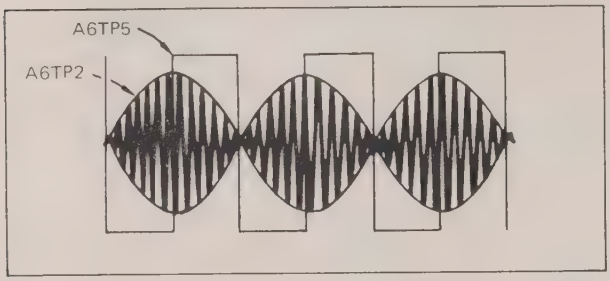
i. Remove ground applied in Step h. above. Remove extender and return card A7 to its receptacle.

j. Press OPER push button and release FREQ MARKS and INTEN MARKS push buttons.

4.2.8 Circuit Card A6

a. Set ANALYSIS RANGE selector to 10K position. Extend card A6 on shielded extender and apply a 2-kHz (1.9 kHz to 2.1 kHz) signal at a level of 0.1V rms (99 mV rms to 101 mV rms) to the SIGNAL INPUT connector on the front panel.

** b. Connect channel 1 probe of a dual-trace oscilloscope to A6TP5 and connect channel 2 probe to A6TP2. Set oscilloscope trigger to channel 1. Adjust A6R42 for an oscilloscope display as shown in the illustration below. The envelope should start from the negative-going edge of the square wave.

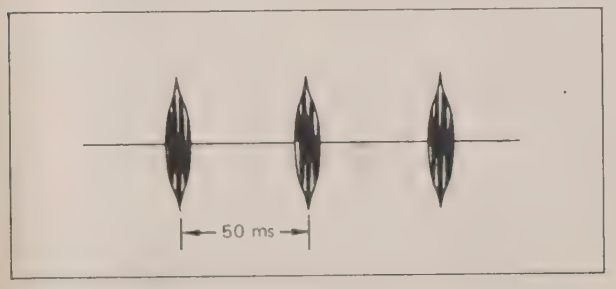


c. Remove signal applied in Step a. above. If there is still an envelope at A6TP2 as shown above, adjust A6L4 to peak the envelope and then adjust A6R35 to reduce the envelope to minimum value.

d. Re-apply the signal that was used in Steps a. and b. above and adjust A6R18 so that the envelope is symmetrical around the negative-going edge of square wave at A6TP5, as illustrated above.

e. Repeat Steps b. and d. above until any interaction ceases.

f. Connect oscilloscope probe to A6TP4, press INPUT RANGE/CAL .316 Vrms push button and OUTPUT GAIN (dB) 10 push button and observe that waveform at A6TP4 is as shown below. Adjust A6L5 to peak the waveform and observe that its amplitude is 1.2V p-p to 1.5V p-p. If the p-p voltage is not within tolerance, simultaneously adjust A6R38 and A6R42 for the correct voltage while maintaining the relationship established in Step d. above. Record the actual voltage value.



g. Press INPUT RANGE/CAL .1 Vrms push button and OUTPUT GAIN (dB) 0 push button.

h. Adjust A6R78 for the p-p voltage value recorded in Step f. above.

i. Press INPUT RANGE/CAL 1 Vrms push button and OUTPUT GAIN (dB) 20 push button.

j. Adjust A6R62 for the p-p voltage value recorded in Step f. above.

k. Remove extender and return card A6 to its receptacle.

l. Repeat Step g. above.

4.2.9 Circuit Card A8

a. Connect counter to junction of A8U1 Pin 8 and A8R2 and adjust A8C5 for 4.800 MHz (4.797 MHz to 4.803 MHz).

b. Extend card A8 on shielded extender, press Y DISPLAY LIN push button and connect oscilloscope probe to A8TP5. The oscilloscope display is a linear step spectrum that is occurring every 50 ms. Tune the input signal frequency to peak the spectrum display, then adjust A8R10 for a peak amplitude of 5.6V (5.4V to 5.8V). Next, adjust A8R107 until the output OVERLOAD indicator just lights. Finally, adjust A8R10 for a peak amplitude of 5.0V (4.9V to 5.1V). The OVERLOAD indicator should not be lit.

c. Press INPUT RANGE/CAL 3.16 Vrms push button and adjust A8R30 for a base line at A8TP5 of 0 mV to −10 mV) so that amplitude of the 5-kHz sampling pulses on the base line is less than +10 mV.

d. Connect oscilloscope probe to A8TP7 and adjust A8R71 for a base line of 200 mV (150 mV to 250 mV).

e. Remove extender and return card A8 to its receptacle.

f. Press INPUT RANGE .1 Vrms push button.

4.2.10 Circuit Card A31 and High-Voltage Power Supply A32

WARNING

Voltages dangerous to life are present on card A31 and High-Voltage Power Supply A32.

a. Turn INTENSITY control on front panel to a point between 10 and 20 percent of its range from the full CCW position and adjust A32R15 until the display just

disappears. Turn INTENSITY control to the center of its range and adjust the FOCUS control and A31R27 (astigmatism control) to obtain sharpest display.

b. Press SCOPE SPECT push button and adjust A31R42 for a full-scale indication on the INPUT meter.

c. Press CAL SPECT push button and adjust A13R47 for a full-scale indication on the INPUT meter.

d. Press OPER push button.

4.2.11 Circuit Card A2 Dither Adjustment

NOTE

To avoid a possible needless search for the right combination of adjustments, perform Steps a. thru c. of this procedure without disturbing adjustment controls A2R57 and A2R7. If the observed indications are within specified limits, perform Step d., then proceed to Paragraph 4.2.12.

a. Extend card A2 and remove signal from SIGNAL INPUT connector on front panel. Connect oscilloscope probe to emitter of A2Q6 and adjust A2R57 for noise level of 75 mV p-p (50 mV to 100 mV p-p).

b. Connect DVM to A2TP4 and apply a 3-kHz (2.9 kHz to 3.1 kHz) sine wave at a level of 0.1V rms to SIGNAL INPUT connector on front panel. Set ANALYSIS RANGE selector to 10K position and press INPUT RANGE/CAL 10 Vrms push button. Adjust A2R7 for a displayed spectrum level of –40 dB (–38 dB to –42 dB). While adjusting A2R7, monitor the DVM to ensure that the voltage at A2TP4 is not less than 2.450V or more than 2.550V when the specified spectrum level is obtained.

c. With the INPUT RANGE/CAL 1, 2, 3 and 4 dB push buttons, select attenuation in 1 dB steps to 8 dB while observing that the displayed spectrum level changes with a ±2 dB accuracy in the –40 to –48 dB range. If the spectrum level does not change as specified, further adjustment of A2R7 (Step b.) is necessary.

d. Release INPUT RANGE/CAL 1, 2, 3 and 4 dB push buttons, press .1 Vrms push button, remove extender and return card A2 and extender to their respective receptacles.

4.2.12 Final Checks

a. Press CAL SPECT push button.

b. Set ANALYSIS RANGE selector to 20K position and observe that spectrum display of square wave CAL signal appears at 30 percent and 90 percent of analysis frequency range.

c. Sequentially set ANALYSIS RANGE selector to each of its remaining positions and observe that after changing ranges, the spectrum display becomes the same as that observed in Step b. above following the memory period of the selected analysis range.

d. Set ANALYSIS RANGE selector to 20K position, press ~~SPECT~~ TIME push button and observe a square wave with approximately 8 complete cycles on the display. (It may be necessary to use the TRIGGER LEVEL control to obtain a display.)

e. Sequentially set ANALYSIS RANGE selector to each of its remaining positions and observe the same square wave display as in Step d. above except in the 25 (Hz) position in which the display is not clear.

NOTE

The remaining steps pertain to the averager section of the SD330 and can be performed only if the averager is applicable to the particular instrument being calibrated.

f. Press OPER push button and SCOPE SPECT push button. Set ANALYSIS RANGE selector to 200 (Hz) position and apply a 40-Hz signal at a level of 0.1 Vrms to the SIGNAL INPUT connector to cause a full-scale indication on the INPUT meter.

g. Press AVG push button, NUMBER OF AVERAGES 1 push button and STOP/STORE push button. Then, press START push button and observe that the spectrum line corresponding to the 40-Hz input frequency appears on the display and the STOP/STORE indicator comes on.

h. Press NUMBER OF AVERAGES 2 push button and observe that the STOP/STORE indicator goes off, the averaging process restarts and that time required to reach selected number of averages is twice the time required in Step g. above. (The STOP/STORE indicator comes on when selected number of averages is reached.)

i. Repeat Step h. above for 4, 8 and 16 averages, observing that the time required to reach selected number

of averages doubles each time the number of averages selected is doubled.

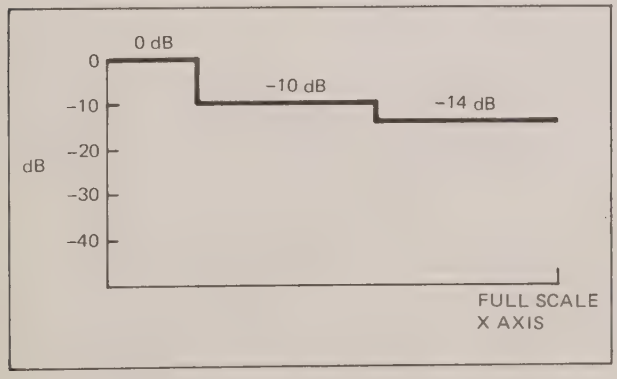
j. Set ANALYSIS RANGE selector to 10K position and change frequency of signal at SIGNAL INPUT connector to 2 kHz. Repeat Step h. above for 32, 64, 128, 256 and 512 averages.

k. Select 64 averages and press EXPO AVG push button. Observe that STOP/STORE indicator starts to flash. Select frequency markers (FREQ MARKS push button depressed) and observe that amplitude of displayed frequency markers increases slowly.

l. Release FREQ MARKS push button and observe slow decay of frequency markers display.

m. Apply a 2-kHz (1.9 kHz to 2.1 kHz) square wave to the SIGNAL INPUT connector and adjust amplitude for full-scale indication on INPUT meter.

n. Press PEAK HOLD push button and observe that STOP/STORE indicator starts flashing and that display consists of three spectrum lines: 2 kHz, 6 kHz and 10 kHz. Slowly reduce frequency of the input signal from 2 kHz to 100 Hz and observe that the display corresponds to the illustration below. Tolerance of specified levels (0 dB, −10 dB and −14 dB) is ±1 dB.



o. Increase frequency of input signal to 1 kHz (990 Hz to 1.1 kHz) then press START push button. Observe that the display of Step n. above is erased and the STOP/STORE indicator goes off but comes on again when 64 averages are completed. Observe that the display consists of spectrum lines at 1, 3, 5, 7 and 9 kHz. After the STOP/STORE indicator comes on, vary the frequency of the input signal and observe that no change occurs in the stored display.

p. Release AVG push button – display now represents current unaveraged data. Press AVG push button – data that was averaged and stored in Step o. above is again displayed.

q. Apply a 2-kHz sine wave to SIGNAL INPUT connector and adjust amplitude for full-scale indication on the INPUT meter. Press STOP/STORE push button then press START push button. When the STOP/STORE indicator comes on, press EXPO AVG push button, then check relative amplitudes of averaged and unaveraged data by alternately pressing and releasing AVG push button. Difference amplitude should be less than 1 dB.

r. Use the INPUT RANGE/CAL push buttons to sequentially provide attenuation values listed below and observe levels of averaged and unaveraged spectrum for each setting of the attenuator (always allowing time for averaged data to settle). The corresponding levels of the averaged and unaveraged spectrums should be as specified below.

INPUT RANGE/CAL Attenuator Setting	Averaged and Unaveraged Spectrum Levels
0 dB	−1 to +1 dB
−10 dB	−9 to −11 dB
−20 dB	−19 to −21 dB
−30 dB	−28 to −32 dB
−40 dB	−37 to −43 dB

s. Restore INPUT RANGE/CAL attenuator setting to 0 dB. Press AVG push button, then press START push button. The STOP/STORE indicator comes on when 64 averages are complete. (No. of averages was selected in Step k. above.)

t. Press MANUAL push button. Release MANUAL push button and observe stored data reappears.

u. Press CAL FREQ push button then momentarily press CAL LIN ZERO push button. Press OPER push button and observe that stored data reappears with no change. Release AVG push button.

v Deenergize Spectrascope.

w. Install top cover.

x. To ensure proper overall operation of the instruments, perform the operational checkout procedure of Section II.

4.3 PARTS REPLACEMENT

Except for some special SDC specification-controlled parts listed in Table 4-2, which must be ordered from Spectral Dynamics Corporation, standard electronic parts have been used throughout the instrument. Although standard, the indicator lamps, switches, CRT and power cord have been included to aid replacement. Spectral Dynamics Corporation maintains a complete stock of all parts and complete printed circuit card assemblies used in this instrument.

When ordering a replacement part or assembly, be sure to include the reference designator, the part number or manufacturer's designation and a complete description. Also include the instrument name, model number and serial number.

CAUTION

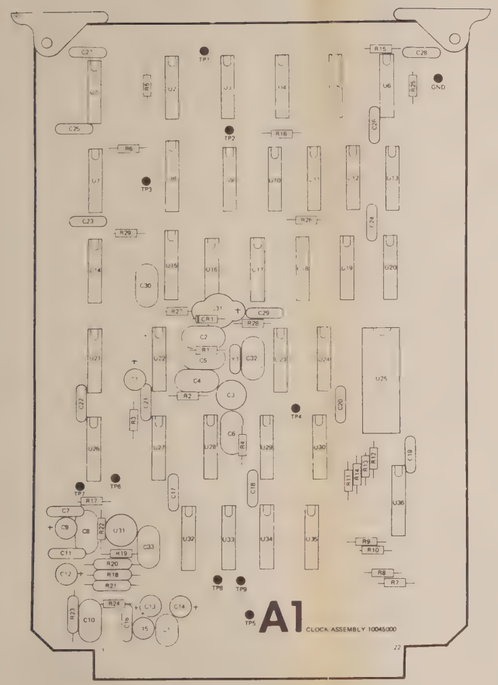
The replacement of an LED (light emitting diode) assembly must be done with extreme care to avoid short circuiting the leads. Before installing a new LED assembly, carefully straighten all 8 leads so that they are aligned and parallel to each other. Then insert all 8 leads simultaneously into the proper holes in the mating receptacle. Press the assembly firmly until the leads are almost bottomed and the front of the LED assembly is approximately parallel with the circuit card. After installation, carefully inspect each lead for possible shorts and/or faulty contacts.

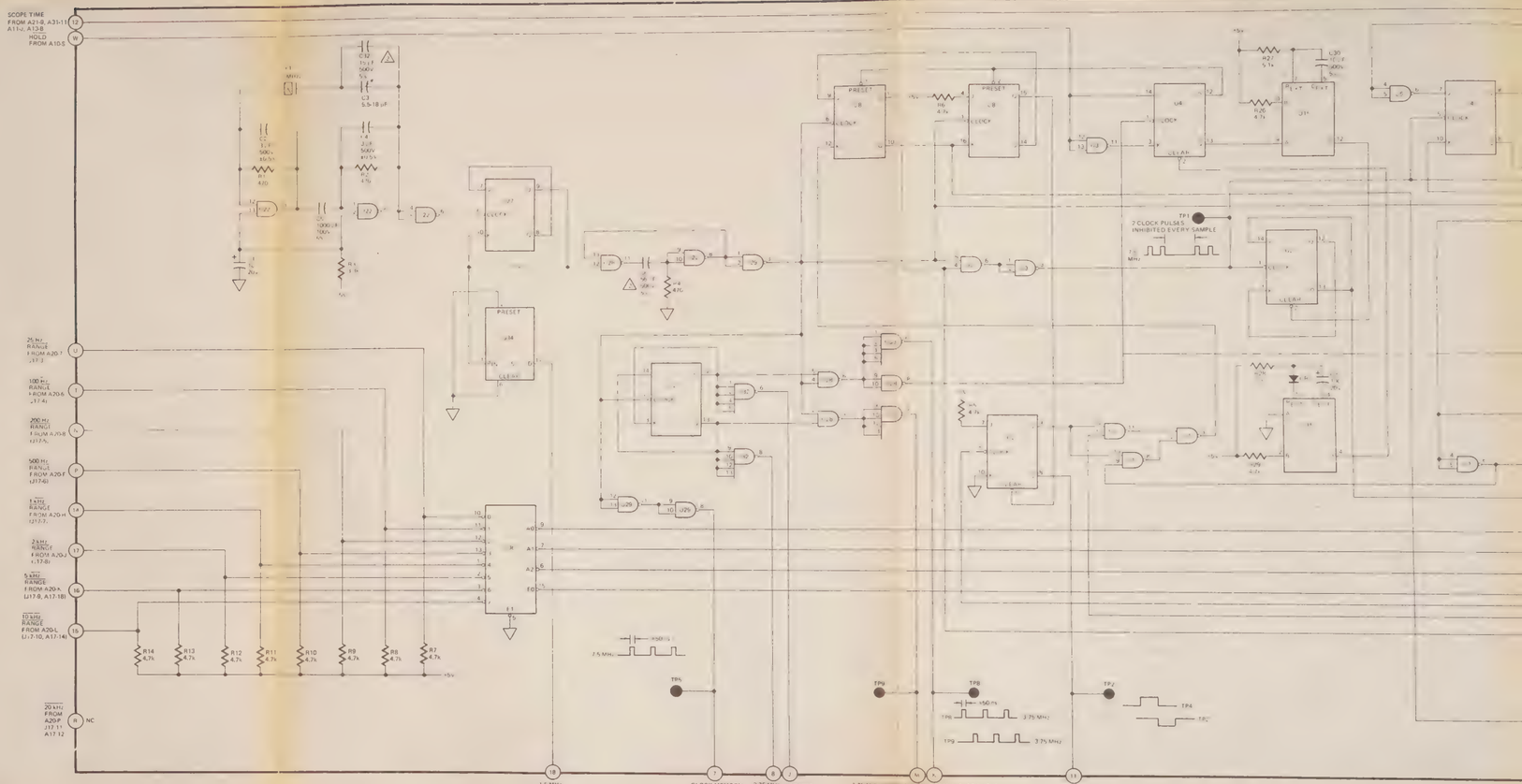
Table 4-2. Special Replaceable Parts List

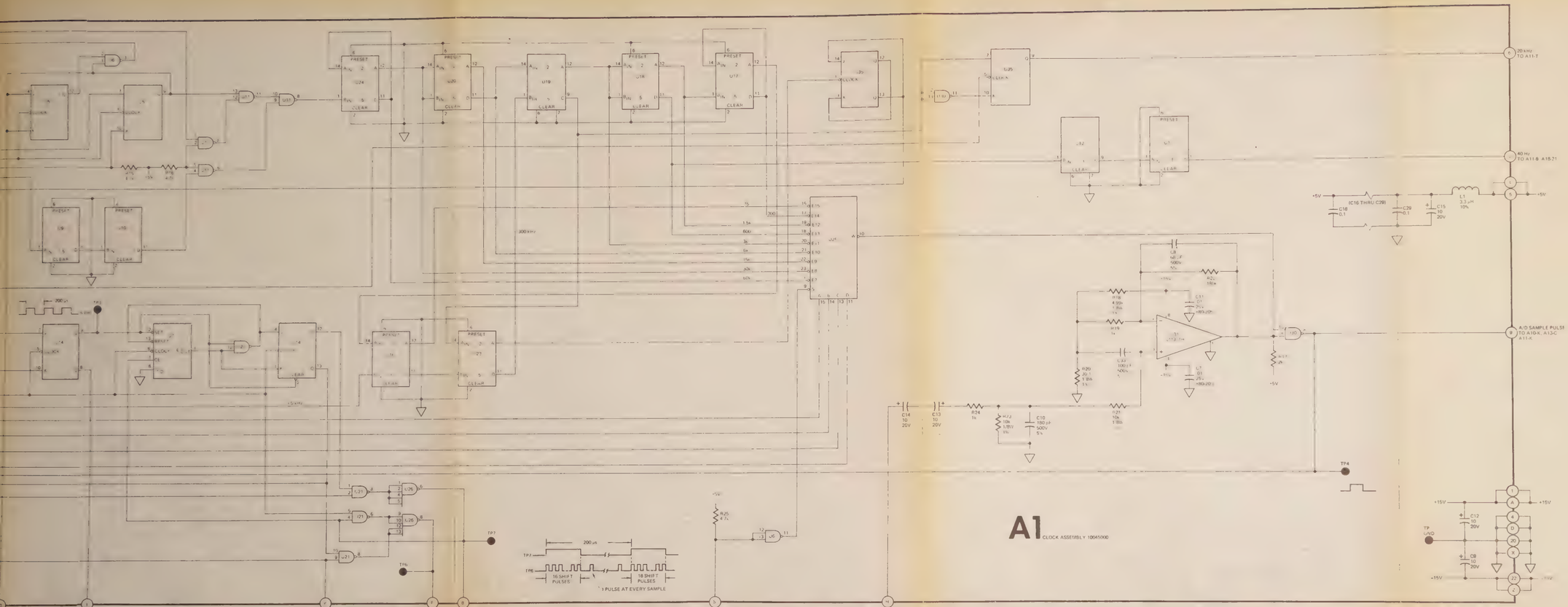
Reference Designator	Description	Part Number/ Mfr. Designation
A1	Circuit Card, Clock	10045000
A2	Circuit Card, A-D Converter	14304-1
A3,A4	Circuit Card, Memory	14310-1
A5	Circuit Card, High-Speed D-A Converter	14312-1
A6	Circuit Card, Scan Mixer	14318-1
A6-FL1	Low-Pass Filter, 1.5-MHz	20013-431
A6-FL2	Bandpass Filter, 5-MHz	20013-386
A7	Circuit Card, Sweep Oscillator	15464-1
A8	Circuit Card, Detector and Output Amplifier	14322-1
A8-Q7, A8-Q10	Transistors (Matched Pair)	20013-044
A9	Extender Card	14412-1
A10	Circuit Card, Display Control/Marker Generator	14330-1
A11	Circuit Card, Counter Control	14328-1
A12	Circuit Card, Counter	14334-1
A13	Circuit Card, BCD Ladder	14336-1
A14	Circuit Card, Averager A-D Converter	14340-1
A15	Circuit Card, Averager Timing	14342-1
A16	Circuit Card, Averager Divide Select	14346-1
A17	Circuit Card, Averager Memory	14348-1
A18	Circuit Card, Averager D-A Converter	14352-1
A19	Circuit Card, Low-Voltage Power Supply	14354-1
A20	Circuit Card, Mother Board (Left)	14414-1
A21	Circuit Card, Mother Board (Right)	14418-1
A22	Circuit Card, Input Range (Coarse)	14362-1
A23	Circuit Card, Input Range (Fine)	14364-1
A24	Input Assembly	14816-1
A24-A1	Circuit Card, Low-Pass Filter	14386-1
A24-M1	Meter, INPUT	20013-457

Table 4-2. Special Replaceable Parts List (Continued)

Reference Designator	Description	Part Number/ Mfr. Designation
A24-S1	Switch, Wafer; ANALYSIS RANGE	20013-456
A24-S2	Switch, Toggle; AC/DC	7101 (C & K)
A24-DS2	Lamp, Indicator, LED; OVERLOAD	MV5025 (Monsanto)
A25	Circuit Card, Operate/Calibrate	14368-1
A26	Circuit Card, Output Gain/ Y Display	10032300
A27	Circuit Card, Number of Averages	14374-1
A28	Circuit Card, Averages Control	14376-1
A29	Circuit Card, Display Functions	14380-1
A30	Circuit Card, Memory/Markers	14382-1
A31	Circuit Card, Horiz. and Vert. Amplifiers	14358-1
A32	Circuit Card, High-Voltage Power Supply	14812-1
	Knob (single index), ANALYSIS RANGE, TRIGGER LEVEL	20013-175
	Knob (gray), Push Button	20013-360-5
	Knob (white), Push Button	20013-360-4
	Knob (red), Push Button	20013-360-3
	Knob (single index), Oscilloscope X-Y	20013-177
	Graticule, Oscilloscope	15119-8
S2	Switch, Thumbwheel; DIGITAL LOCATER	20013-453-3
S3	Switch, Power; 115/230	46256LF (Switchcraft)
S1	Switch, Push Button; POWER	616-6-1 (MARCO-OAK)
DS1	Lamp; POWER	A1H (MARCO-OAK)
DS3,4,5	Lamp, Indicator, LED; OVERLOAD, MEMORY HOLD, STOP/STORE	MV5025 (Monsanto)
T1	Transformer, Power	20013-441
V1	Vacuum Tube, Cathode Ray, 5DEP1F	411-265
	Cover, Low Voltage Power Supply (Rear of Chassis)	14391-7
	Bezel, Display Oscilloscope	15324-1
	Power Cord	17258S (Belden)


A1
CLOCK ASSEMBLY 10045/000


SCOPE TIME FROM A21-9, A31-11, A11-J, A33-B
HOLD FROM A10-S
25 Hz RANGE FROM A20-7 (J17-J)
100 Hz RANGE FROM A20-6 (J17-H)
200 Hz RANGE FROM A20-8 (J17-F)
500 Hz RANGE FROM A20-F (J17-E)
1 kHz RANGE FROM A20-H (J17-D)
2 kHz RANGE FROM A20-J (J17-B)
5 kHz RANGE FROM A20-K (J17-9, A17-18)
10 kHz RANGE FROM A20-L (J17-10, A17-14)
20 kHz FROM A20-P J17-11 A17-12
1.5 MHz TO A10-Y
CLOCK MEMORY 7.5 MHz TO A3-7 A4-7
3.75 MHz TO A3-12 A4-12
3.75 MHz TO A3-8 A4-8
3.75 MHz TO A3-9 A4-9
3.75 MHz CLOCK NO. 1 TO A5-9, A14-21, A29, A3-11, A4-11
SAMPLE TO A2-21
7 CLOCK PULSES INHIBITED EVERY SAMPLE
7.5 MHz
3.75 MHz
TP1
TP4
TP5
TP6
TP7
TP8
TP9



REVISIONS						
REV	ZONE	DESCRIPTION	DATE	APPROVED	CHG NO
A		U13 HEIGHWAY	5/3/73		

NOTES: UNLESS OTHERWISE INDICATED
1. (Ω) RESISTANCE SHOWN IN OHMS
(M) RESISTORS ARE 1/4W ±5%
(μ) CAPACITANCE SHOWN IN MICROFARADS
(P) CAPACITORS @ 12V ±20%
⚠ FACTORY SELECT WITH TYPICAL VALUE SHOWN

INTEGRATED CIRCUITS				
SYMBOL	PART #	PIN NO.		UNUSED GND, VCC
		GND	VCC	
U1,U3,U6,U11 U21 & U30	SN7400N	7	14	J,K,R,K #9SA & B
U2,U4,U5, U14 & U35	SN7403N	7	4	NONE
U8	SN74H76N	13	5	NONE
U9,U10,U13,U16 U17,U18,U26,U27, U34 & U4	SN54S04N	7	14	NONE
U12 & U19	SN7490N	10	5	NONE
U15	SN74S20N	7	14	NONE
U22,U28 & U29	SN74H08N	7	14	U28B
U25	SN74H00N	7	14	NONE
U26,U32 & U33	SN74H40N	7	14	NONE
U27	SN74H13N	7	14	NONE
U36	SN54H04N	7	14	NONE

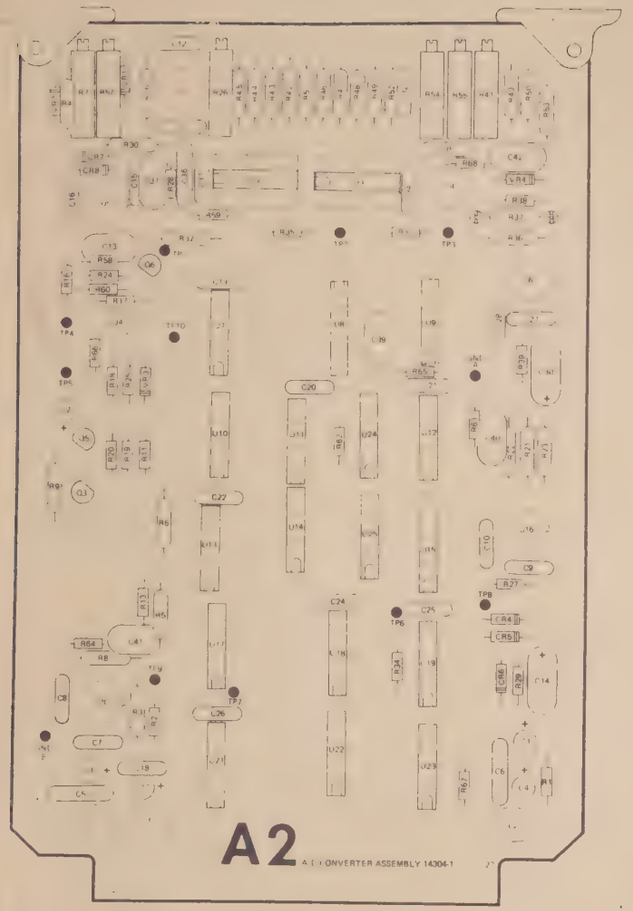
HIGHEST REF DESIG USED
U35
C31
R26
TP10
J18
X1

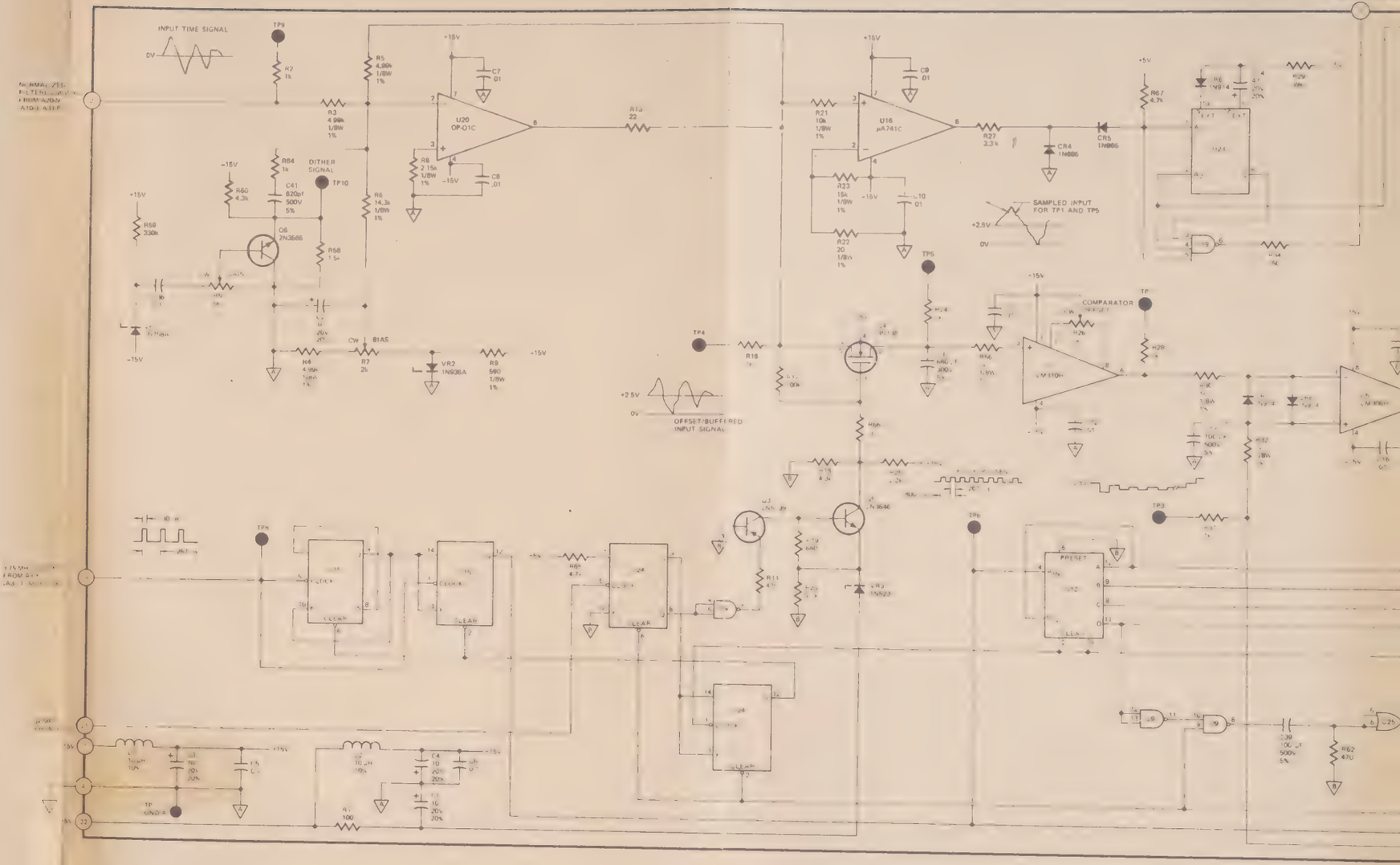
PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.

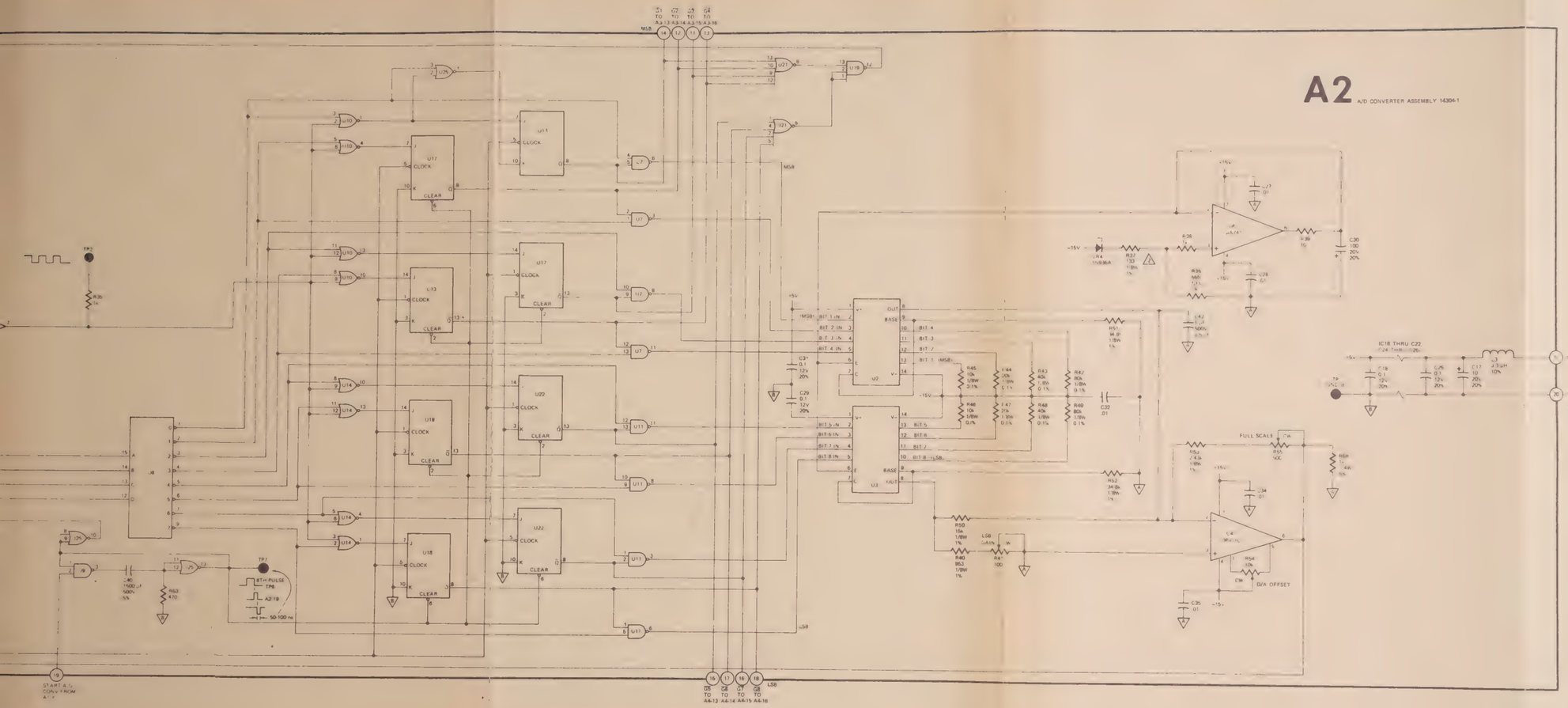
SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

TITLE: SCHEMATIC/COMPONENT LAYOUT CLOCK ASSEMBLY 10045000 A1

DR=WN	L. SALER	1-73	MODEL	SIZE	DRAWING NO.	REV.
DESIGNER			SD330		10044800	A
CHECKED						
ENGINEER			SCALE		SHEET 1 OF 1	
APPROVED						


A2
A/D CONVERTER ASSEMBLY 14304-1


INPUT TIME SIGNAL
DITHER SIGNAL
SAMPLED INPUT FOR TP1 AND TP5
OFFSET/BUFFERED INPUT SIGNAL
COMPARATOR
U20 OP-01C
U16 µA741C
CR4 1N686
CR5 1N986
VR2 1N936A
Q6 2N3686
PRESET
CLEAR
GND



REVISIONS						
	---	011	REDRAWN	LJS 12-72		
	4613	186	R36 WAS 1.5k, R37 WAS 301 AND ADDED FACTORY ADJUST TO R37	JBC 4-73		
	---	---	DELETED Q1 Q2 CR1 CR2 R10 R17 R14 R15	---	R4	

NOTES: UNLESS OTHERWISE INDICATED

1. (a) RESISTANCE SHOWN IN OHMS
   (b) RESISTORS ARE 1/4W 5%
   (c) CAPACITANCE SHOWN IN MICROFARADS
   (d) CAPACITORS @ 25V +80-20%

⚠ FACTORY ADJUST WITH TYPICAL VALUE SHOWN

INTEGRATED CIRCUITS

REF. DESIG.	PART No.	PIN GND	PIN +5V	UNUSED CIRCUITS
U2	8018C			NONE
U3	8018C			NONE
U7 & U11	SN7408N	7	14	NONE
U8	SN7442N	8	16	NONE
U9	SN7400N	7	14	NONE
U10 & U14	SN7402N	7	14	NONE
U12	SN7480N	10	5	NONE
U13, U15, U17, U18, U22 & U24	SN7473N	11	4	NONE
U19	SN7410N	7	14	U18C
U21	SN7425N	7	14	NONE
U23	SN74122N	7	14	NONE
U26	SN7404N	7	14	NONE

HIGHEST REF. DESIG. USED

C42
CR8
J2
J6
R68
TP9
U26
VR4

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.

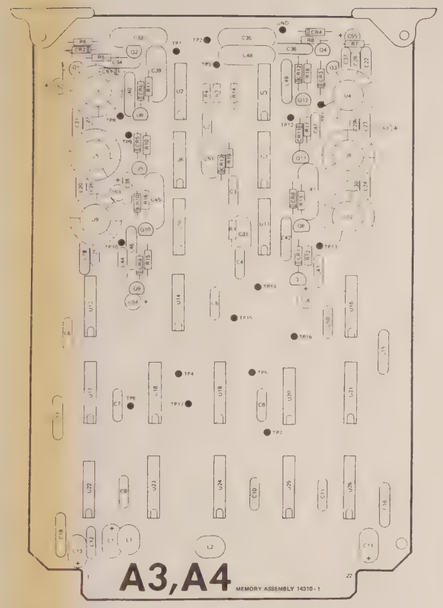
SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

DRAWN	SAUER	12-72
DESIGNER		
CHECKED		
ENGINEER		
APPROVED		

TITLE: SCHEMATIC/COMPONENT LAYOUT
A/D CONVERTER
ASSEMBLY 14304-1
A2

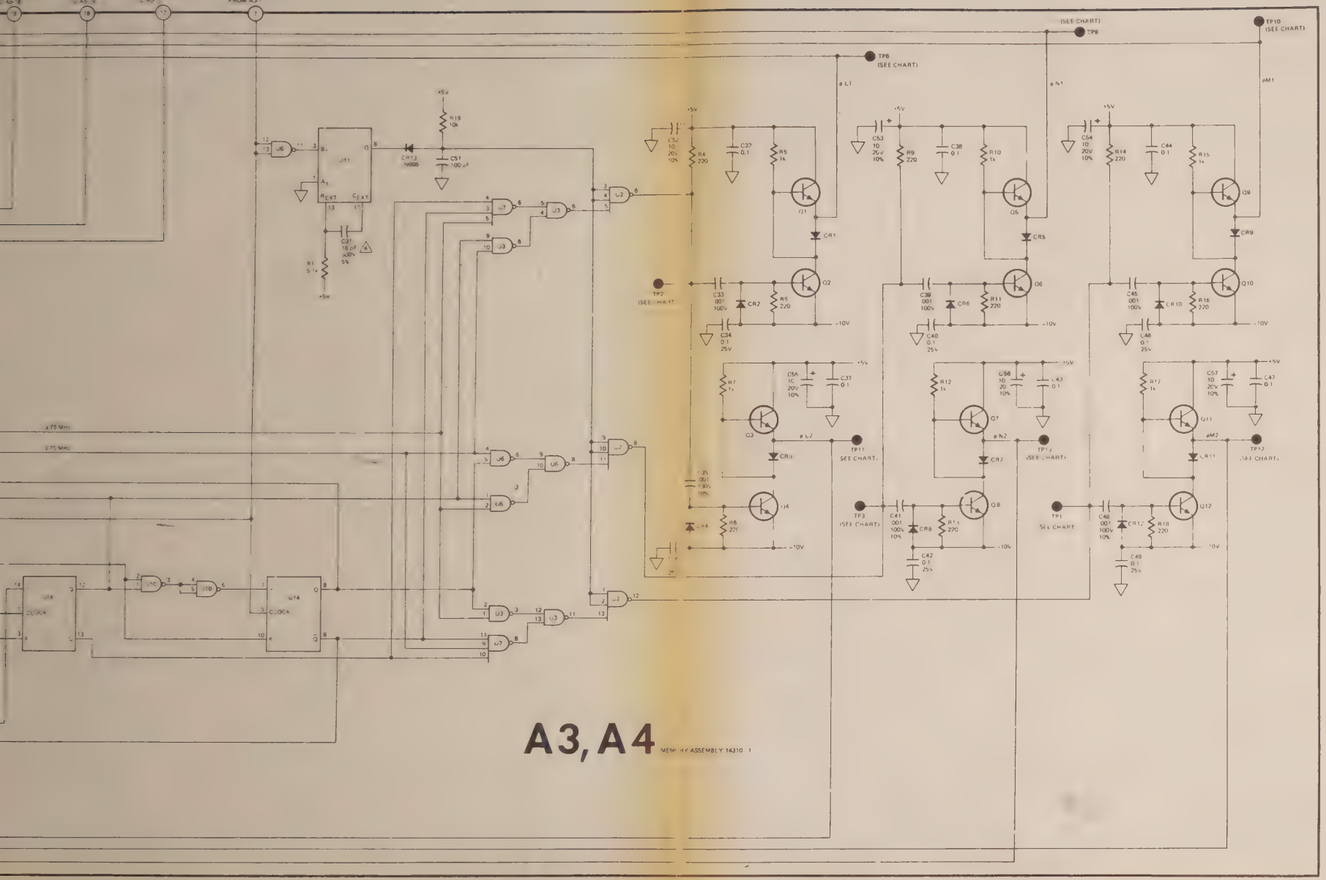
MODEL	SIZE	DRAWING NO	REV
SD330		14302	K

SCALE | SHEET OF



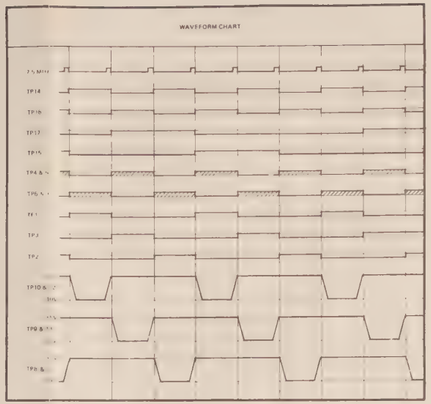
A3,A4

MEMORY ASSEMBLY 14310-1



A3, A4

MEMORY ASSEMBLY 14310-1



NOTES: UNLESS OTHERWISE INDICATED

1. (a) RESISTANCE SHOWN IN OHMS
   (b) RESISTORS ARE 1/4W ±5%
   (c) CAPACITANCE SHOWN IN MICROFARADS
   (d) CAPACITORS @ 12V ±20% 25V ARE +80% -20%
2. DIODES ARE TYPE 1N914
3. TRANSISTORS ARE TYPE 2N5772
4. FACTORY ADJUST WITH TYPICAL VALUE SHOWN

INTEGRATED CIRCUITS

REF. DESIG.	PART NO	PWR PINS GND	PWR PINS VCC	UNUSED CIRCUITS
U1, U4, U5, U8, U9, U12	TMS3402LC			NONE
U2	SN74H11N	7	14	NONE
U3, U6, U10	SN74H00N	7	14	NONE
U7	SN74H10N	7	14	U3-A
U11	SN74127N	7	14	NONE
U13, U16	SN74157N	5	4	NONE
U14 U17, U21, U22	SN74H73N	11	5	NONE
U18	SN74185N	8	16	NONE
U19, U19	SN74153N	8	16	NONE
U20	SN74H51N	7	14	NONE
U23 U25	MC3329P	8	16	NONE
U24	SN7475N	12	5	NONE

HIGHEST REF DESIG USED
R37
CR13
L2
T37
R38
TP17
U26

REVISIONS

REV	ECO	BY	DESCRIPTION	DRAFT	CHECK	APPD
C	—	011	REDRAWN	RVM 12-72		

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.

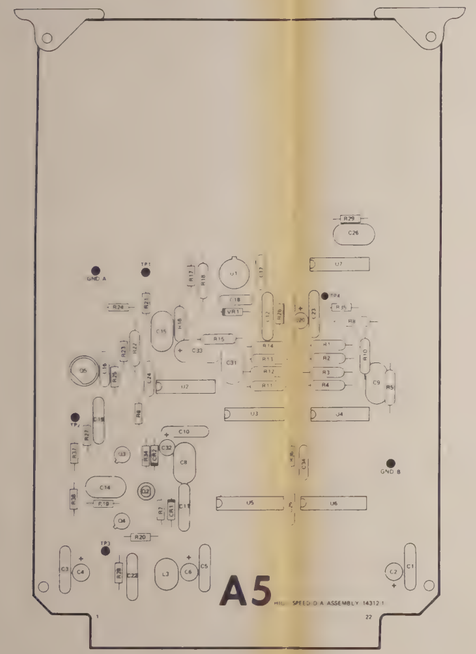
SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

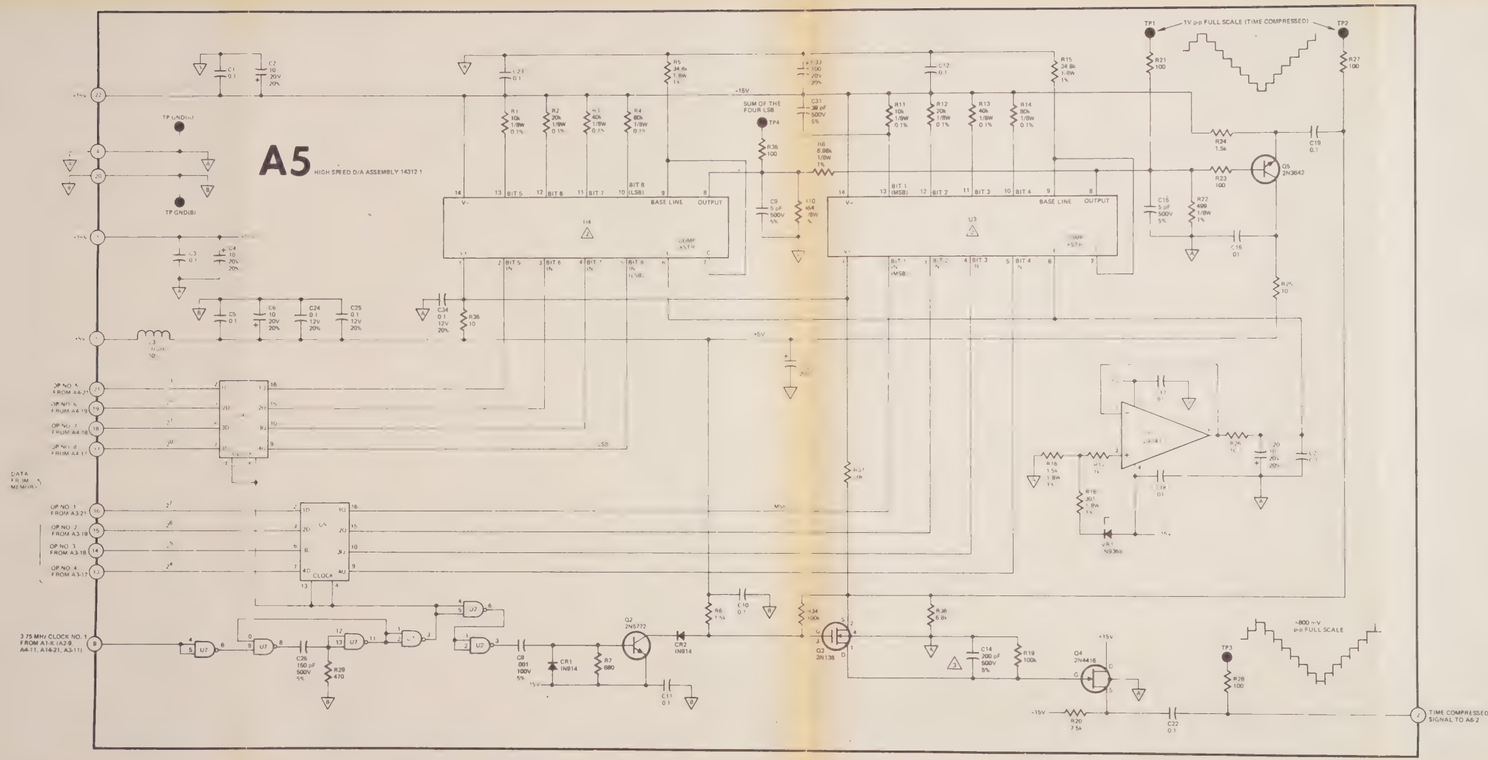
DRAWN	R.V. MOODY	12-72
DESIGNER		
CHECKED		
ENGINEER		
APPROVED		

TITLE: SCHEMATIC/COMPONENT LAYOUT
MEMORY
ASSEMBLY 14310-1
A3, A4

MODEL	SIZE	DRAWING NO	REV
SD 330		14308	C

SCALE | SHEET 1 OF 1





REVISIONS						
REV	ECO	L/W	DESCRIPTION	DRAFT	CHK'D	APPD
E	—	011	REDRAWN	R. W. 12/72		
F	1445	138	C14 WAS 300 pF. ADDED F. A. TO C14	CBC 5/73		

NOTES: UNLESS OTHERWISE INDICATED

1. (a) RESISTANCE SHOWN IN OHMS.
   (b) RESISTORS ARE 1/4W ±5%.
   (c) CAPACITANCE SHOWN IN MICROFARADS.
   (d) CAPACITORS @ 25V, +80% -20%.

⚠3 U3 & U4 ARE A MATCHED PAIR. THE "X" IN THE PART NO. INDICATES A NUMBER BETWEEN 0 & 9 USED AS A MATCHING INDICATOR

⚠1 FACTORY ADJUST WITH TYPICAL VALUE SHOWN

INTEGRATED CIRCUITS				
REF. DESIG.	PART NO.	PWR PINS GND	PWR PINS VCC	UNUSED CIRCUITS
U2, U7	SN7400N		14	NAND GATE
U3	HUGHES (A1K-P1)			NONE
U4	HUGHES (A1K-P1)			NONE
U5, U6	SN74154N	12	5	NONE

HIGHEST REF DESIG. USED

U4
U7
J1
R38
TP4
U7
VR1

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

DRAWN	R.V. McCOY	12-72
DESIGNER		
CHECKED		
ENGINEER		
APPROVED		

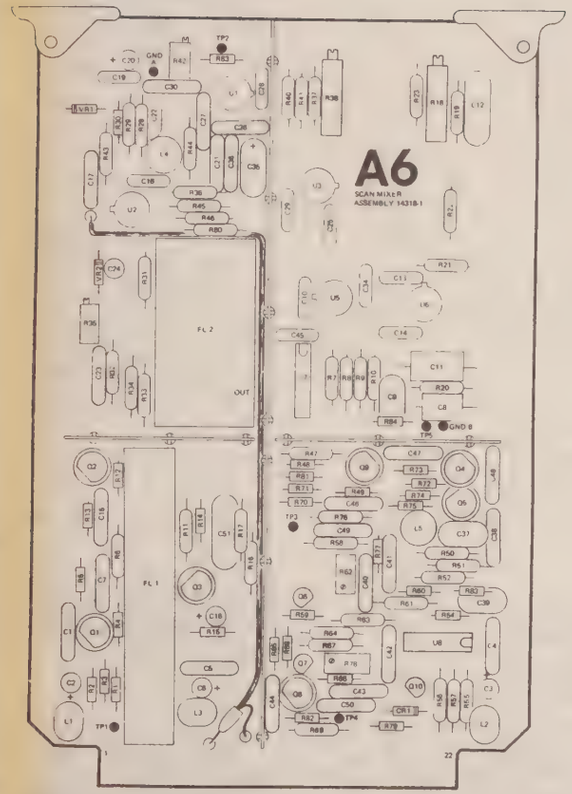
TITLE: SCHEMATIC/COMPONENT LAYOUT HIGH SPEED D/A ASSEMBLY 14312-1

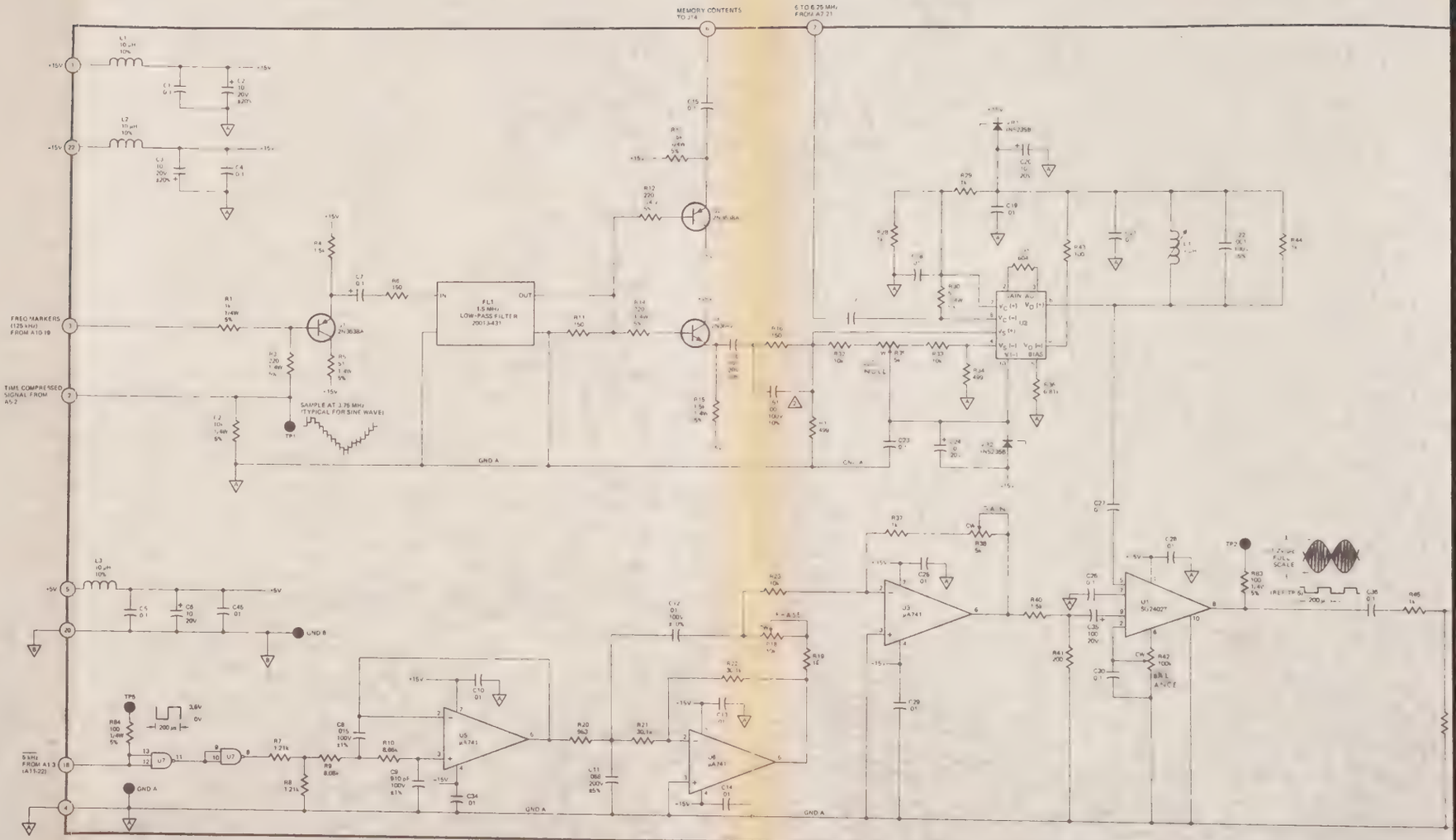
A5

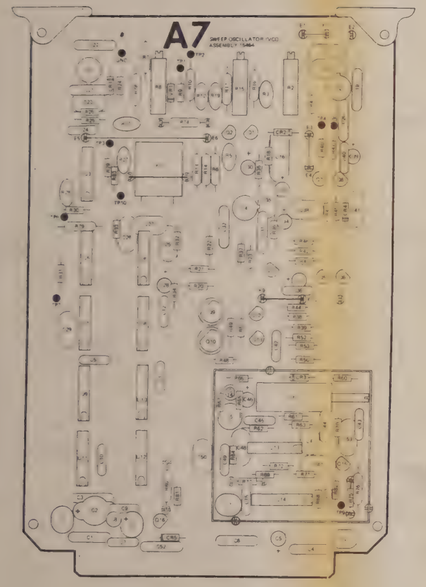
MODEL	SIZE	DRAWING NO.	REV
SD330		14313	F

SCALE

SHEET 1 OF 1


A6
SCAN MIXER
ASSEMBLY 14318-1
FL 2
FL 1
OUT


MEMORY CONTENTS TO J14
6 TO 6.25 MHz FROM A7 J1
+15V
-15V
+5V
GND A
GND B
FREQ MARKERS (125 kHz) FROM A10 J9
TIME COMPRESSED SIGNAL FROM A5 J2
5 kHz FROM A13 (A11-J2)
FL1 1.5 MHz LOW-PASS FILTER 20013-431
SAMPLE AT 3.76 MHz (TYPICAL FOR SINE WAVE)
GAIN ADJ
BIAS ADJ
NULL
REF TP2
200 µs



A7

SWEEP OSCILLATOR (VCO) ASSEMBLY 15464

REVISIONS							
LTR	ECN	BY	DESCRIPTION	APP'D	DATE		
1	1115	DT	RE-DRAWN		7/72		
	1185	DT	R30 WAS 4.7K		5/73		

NOTES: UNLESS OTHERWISE INDICATED:
1. (Ω) RESISTANCE SHOWN IN OHMS
2. (W) RESISTORS ARE 1/4W ±5%
3. (μF) CAPACITANCE SHOWN IN MICROFARADS
4. (#) CAPACITORS @ 25V, +80-20%
△ FACTORY ADJUST WITH TYPICAL VALUE SHOWN
□ SYMBOL: ▭ INDICATES FRONT PANEL LOCATION

INTEGRATED CIRCUITS

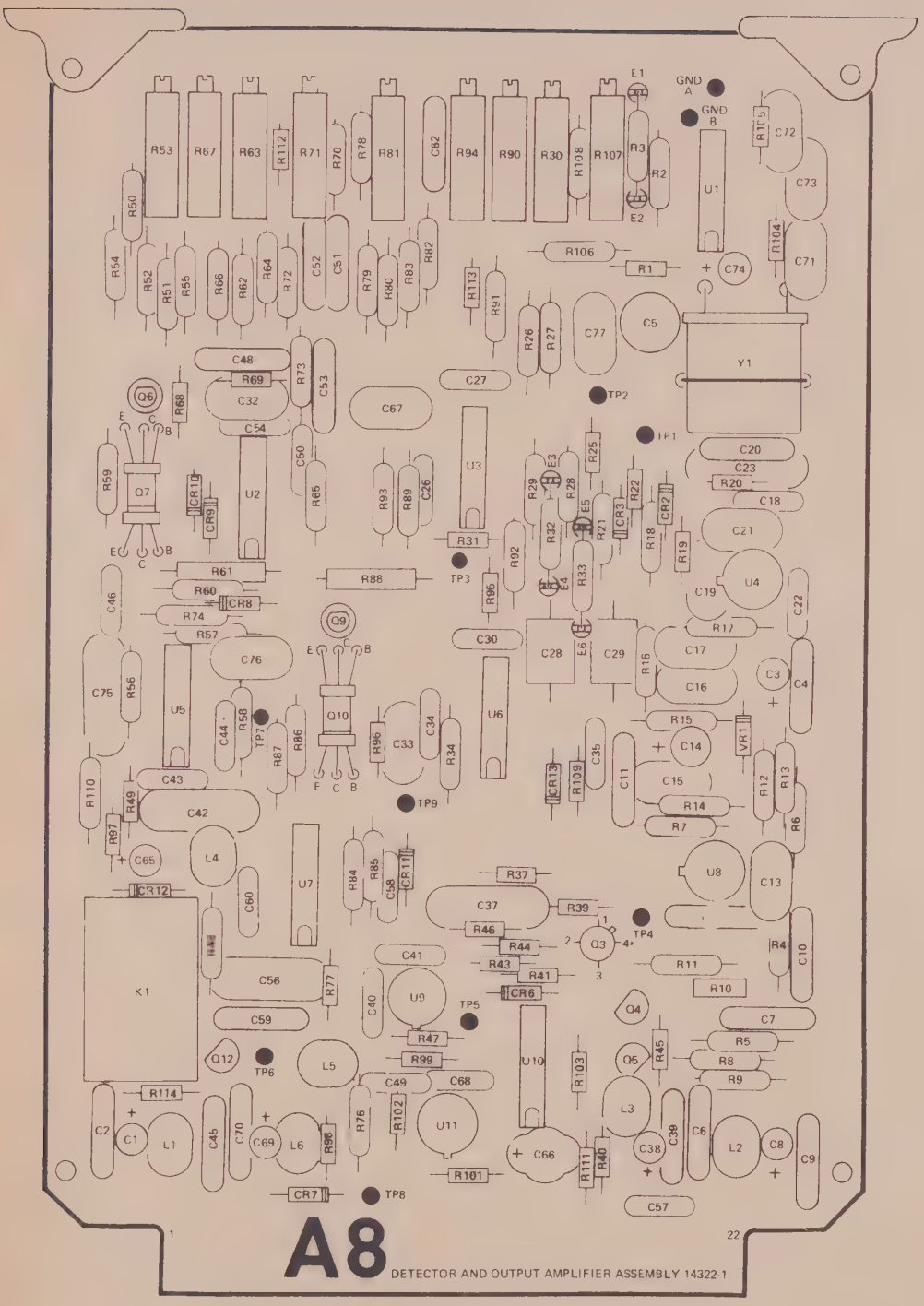
REF DESIG	PART NO	PIN NO. GND	PIN NO. VCC	UNUSED CIRCUITS
U3	8013C	—	—	NONE
U5	SN7474N	7	14	NONE
U6 & U12	SN7400N	7	14	U6-A & U12-B
U7	SN74122N	8	14	NONE
U8, U9, U10 & U13	SN7490N	10	5	NONE
U14	SN74193N	8	16	NONE

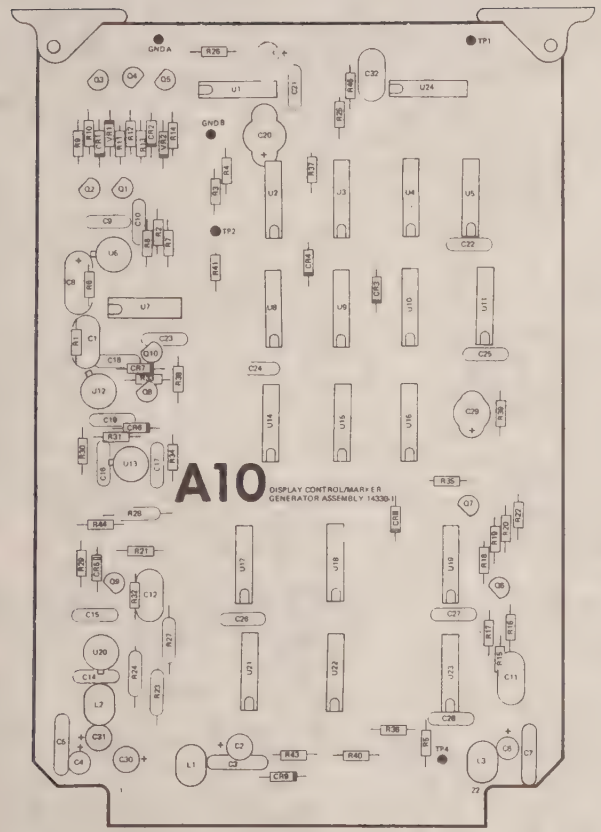
PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, sale, and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.

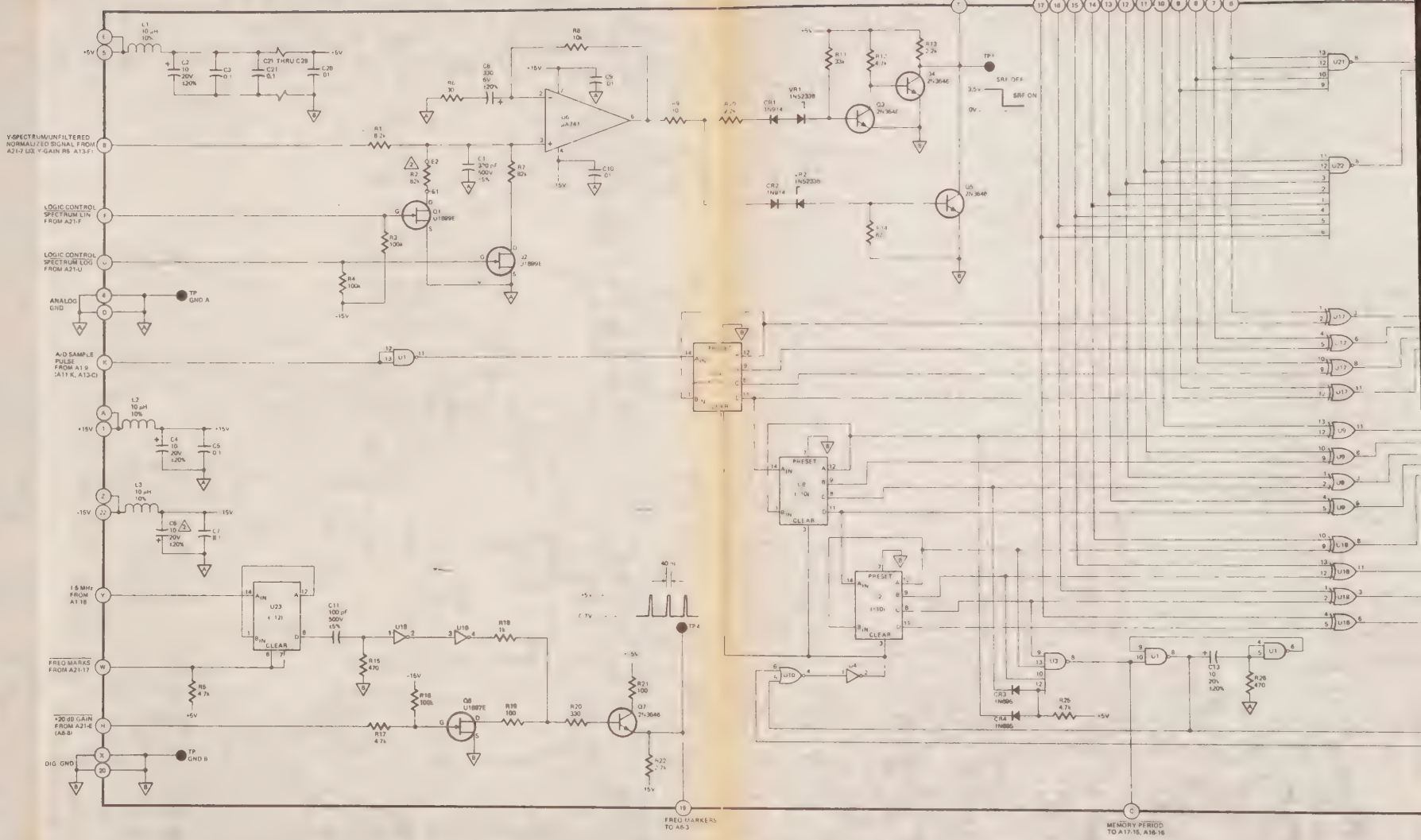
SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

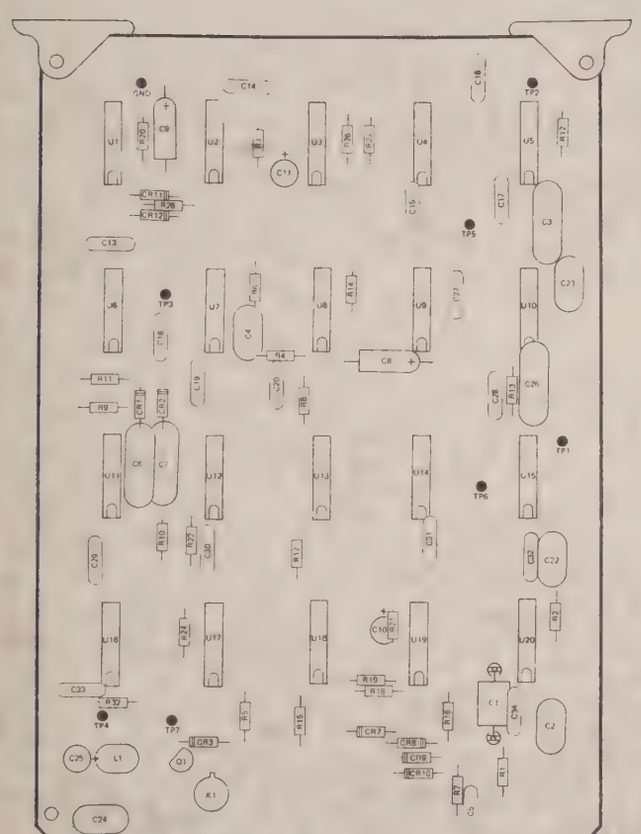
TITLE: SCHEMATIC/COMPONENT LAYOUT SWEEP OSCILLATOR (VCO) ASSEMBLY 15464-1 — A7

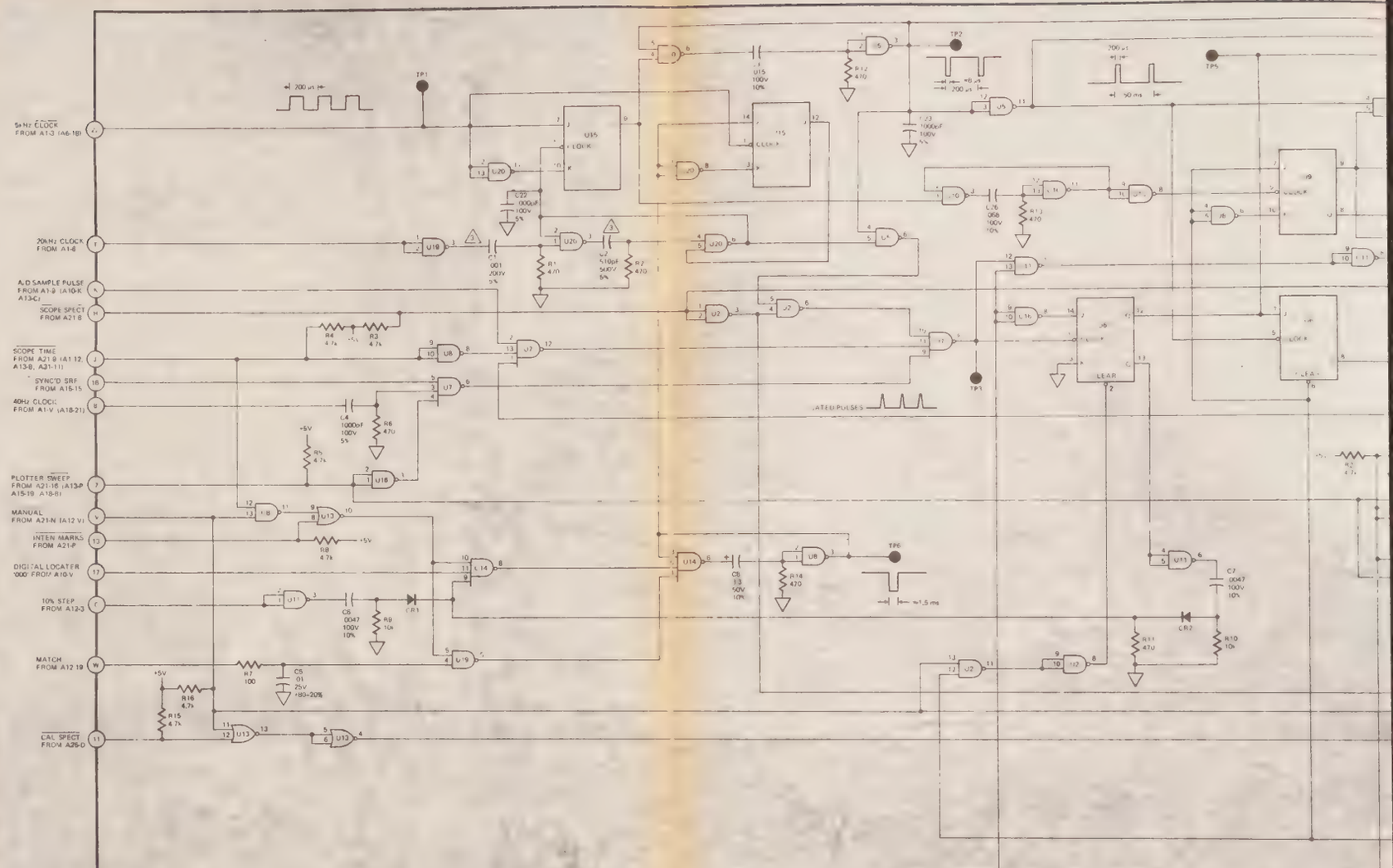
DRAWN	D. SKYGLES	11-72	MODEL: SD330	SIZE:	DRAWING NO: 15466	REV: P
DESIGNED			SCALE:	SHEET OF 1
CHECKED				
ENGINEER				
APPROVED				

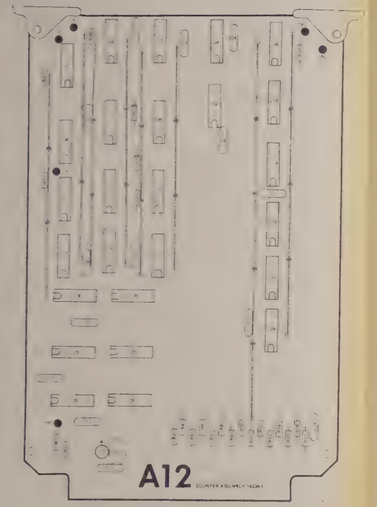

A8
DETECTOR AND OUTPUT AMPLIFIER ASSEMBLY 14322-1
1
22
GND A
GND B
E1
E2
E3
E4
E5
E6
R53
R67
R63
R112
R71
R70
R78
R81
C62
R94
R90
R30
R108
R107
R3
R2
U1
R50
R54
R52
R61
R55
R66
R62
R64
R72
C52
C51
R79
R80
R83
R82
R113
R91
R106
R1
C74
R104
C72
C73
C71
C77
C5
Y1
C48
R69
R73
C53
C27
R26
R27
TP2
C32
C67
C54
C50
U3
TP1
C20
C23
R20
C18
R59
Q7
CR10
CR9
U2
R65
R93
R89
C26
R25
R29
R28
R22
CR3
CR2
C21
R68
Q6
R31
R32
R21
R18
R19
C19
U4
C22
R61
R88
TP3
R92
R96
R33
R60
CR8
C46
R74
R57
Q9
C30
C28
C29
R16
R17
C17
C3
C4
C76
C16
C75
R56
U5
Q10
C44
R58
TP7
C33
C34
U6
R15
C14
VR1
R87
R86
R34
C35
C43
C11
C15
R12
R13
R110
R49
C42
TP9
CR13
R109
R14
R6
R97
R7
C65
L4
U7
R84
R85
C58
CR11
R37
U8
C13
CR12
C37
R39
R46
TP4
C60
R44
Q3
R4
C10
K1
R43
R41
R11
C41
C56
R77
C40
U9
CR6
R10
TP5
Q4
C59
C7
R47
R5
Q12
TP6
L5
R99
U10
R103
Q5
R45
R8
C49
C68
R9
R114
L3
C38
C6
L2
C8
C2
C1
L1
C45
C70
C69
L6
R98
R76
R102
U11
C66
R111
R40
C9
R101
CR7
TP8
C57

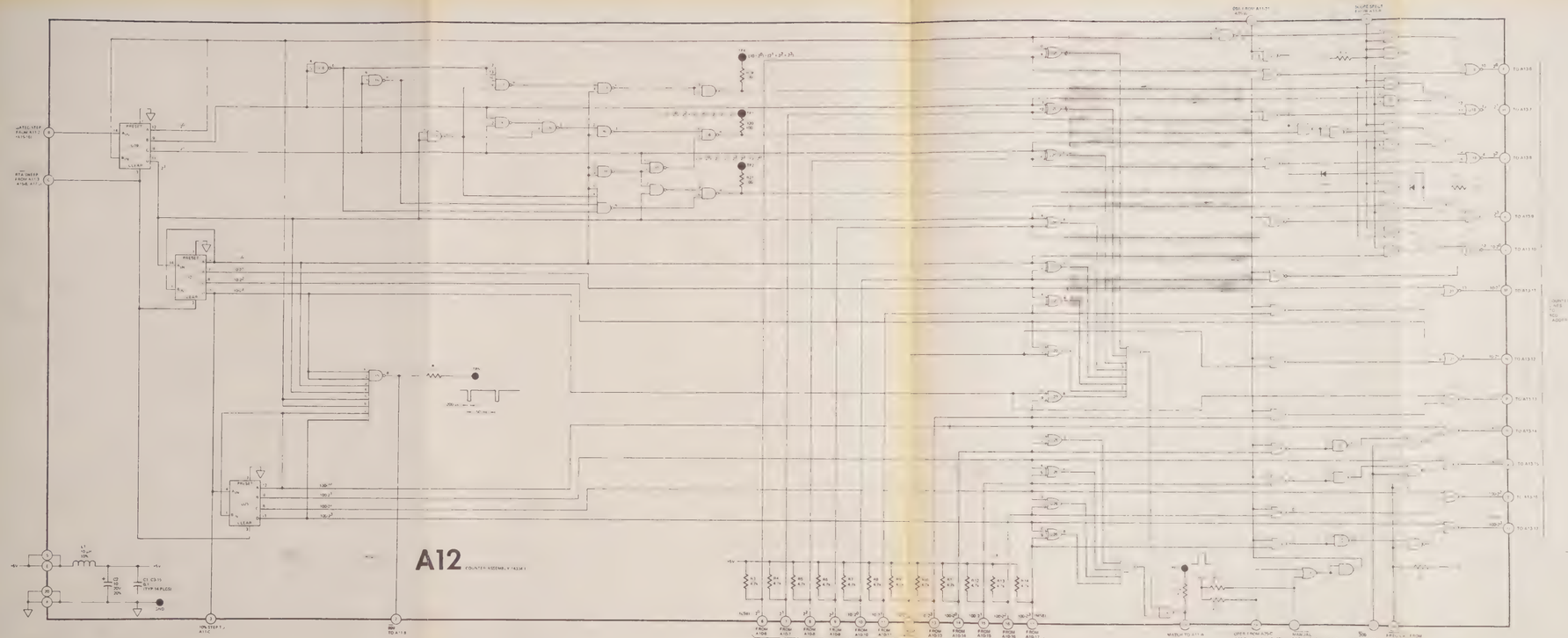

A10
DISPLAY CONTROL/MARKER GENERATOR ASSEMBLY 14330-1


FROM DIGITAL LOCATER S2
SHF TO A15-7
Y-SPECTRUM/UNFILTERED NORMALIZED SIGNAL FROM A21-7 (OR Y-GAIN R5 A13-F)
LOGIC CONTROL SPECTRUM LIN FROM A21-F
LOGIC CONTROL SPECTRUM LOG FROM A21-U
ANALOG GND
A/D SAMPLE PULSE FROM A19 (A17-K, A13-C)
15 MHz FROM A1-18
FREQ MARKS FROM A21-17
+20 dB GAIN FROM A21-E (A6-8)
DIG. GND
SAF OFF
SAF ON
FREQ MARKERS TO A6-3
MEMORY PERIOD TO A17-15, A16-16


A11
COUNTER CONTROL ASSEMBLY 14328-1


5-MHz CLOCK FROM A1-3 (A6-18)
20kHz CLOCK FROM A1-8
A/D SAMPLE PULSE FROM A1-9 (A10-K A13-C)
SCOPE SPECT FROM A21-8
SCOPE TIME FROM A21-9 (A1-12, A13-B, A31-11)
SYNC'D SRF FROM A15-15
40kHz CLOCK FROM A1-V (A18-21)
PLOTTER SWEEP FROM A21-16 (A13-P A15-19, A18-8)
MANUAL FROM A21-N (A12-V)
INTEN MARKS FROM A21-P
DIGITAL LOCATER '000' FROM A10-V
10% STEP FROM A12-3
MATCH FROM A12-19
CAL SPECT FROM A26-D
999 FROM A12-2
SYNC
FROM A1
TP1
TP2
TP5
TP6
200 µs
50 ms
≈1.5 ms
+5V
U15 100V 10%
C23 1000pF 100V 5%
C22 1000pF 100V 5%
C1 001 200V 5%
C2 4700pF 500V 5%
C4 1000pF 100V 5%
C5 0047 100V 10%
C6 13 50V 10%
C7 0047 100V 10%
C8 01 25V +80-20%
R1 47k
R2 47k
R3 47k
R4 47k
R5 47k
R6 470
R7 470
R8 47k
R9 10k
R10 10k
R11 47k
R12 470
R13 470
R14 470
R15 47k
R16 47k
R17 100
CR1
CR2
LEAR
ATED PULSES



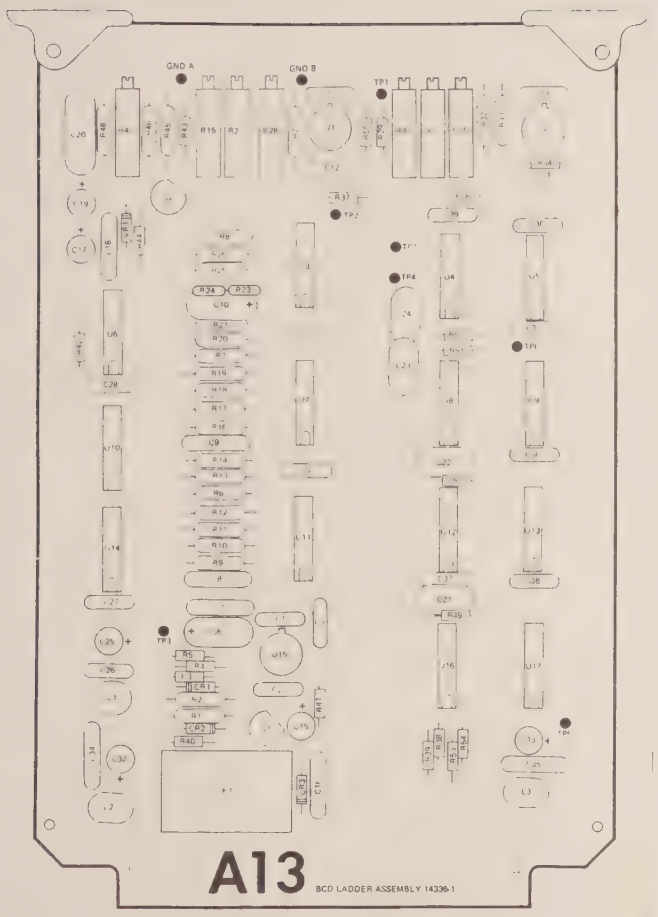


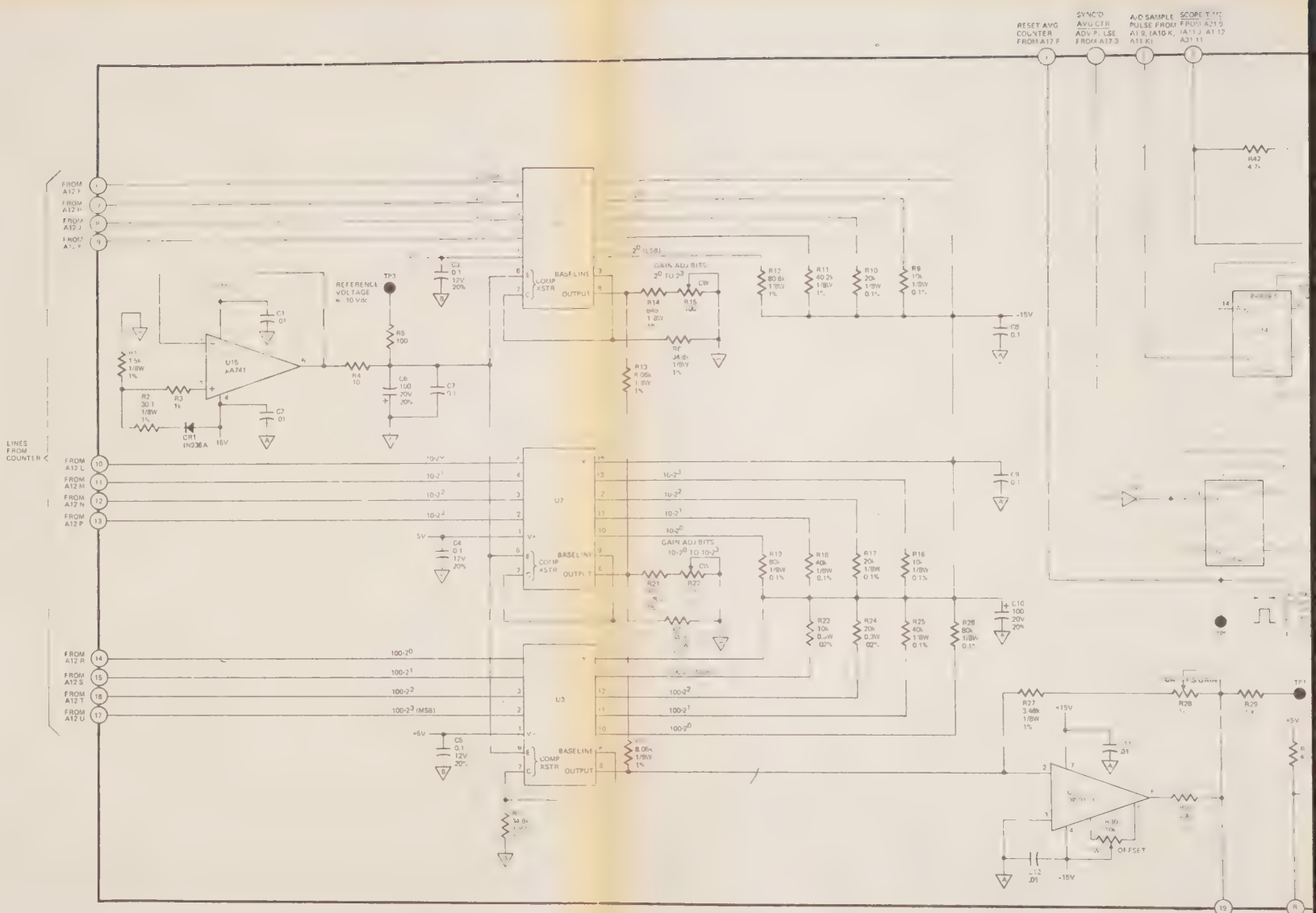
SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

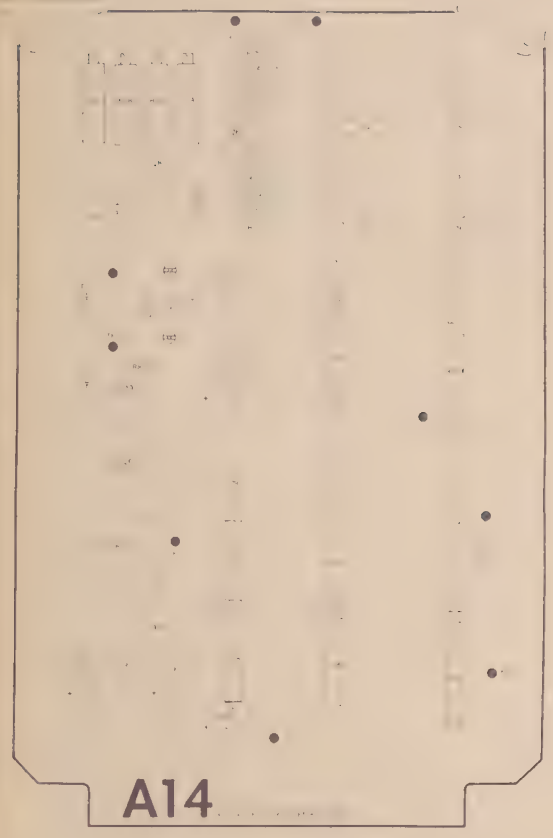
TITLE: SCHEMATIC & COMPONENT LAYOUT
COUNTER
ASSEMBLY 14334-1

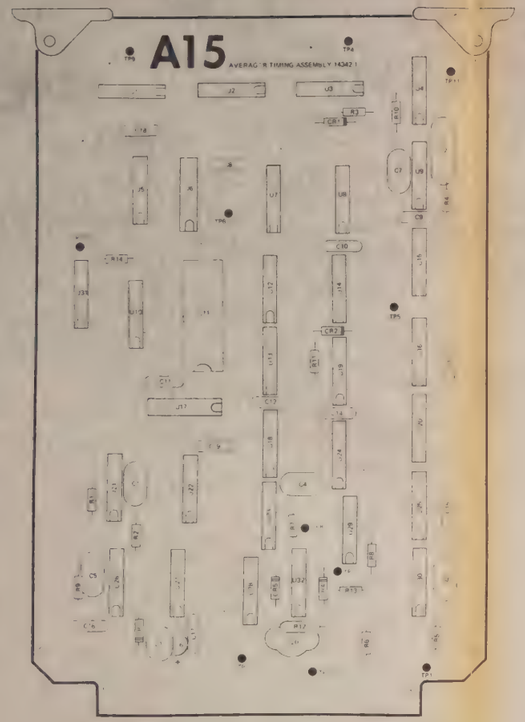
A12

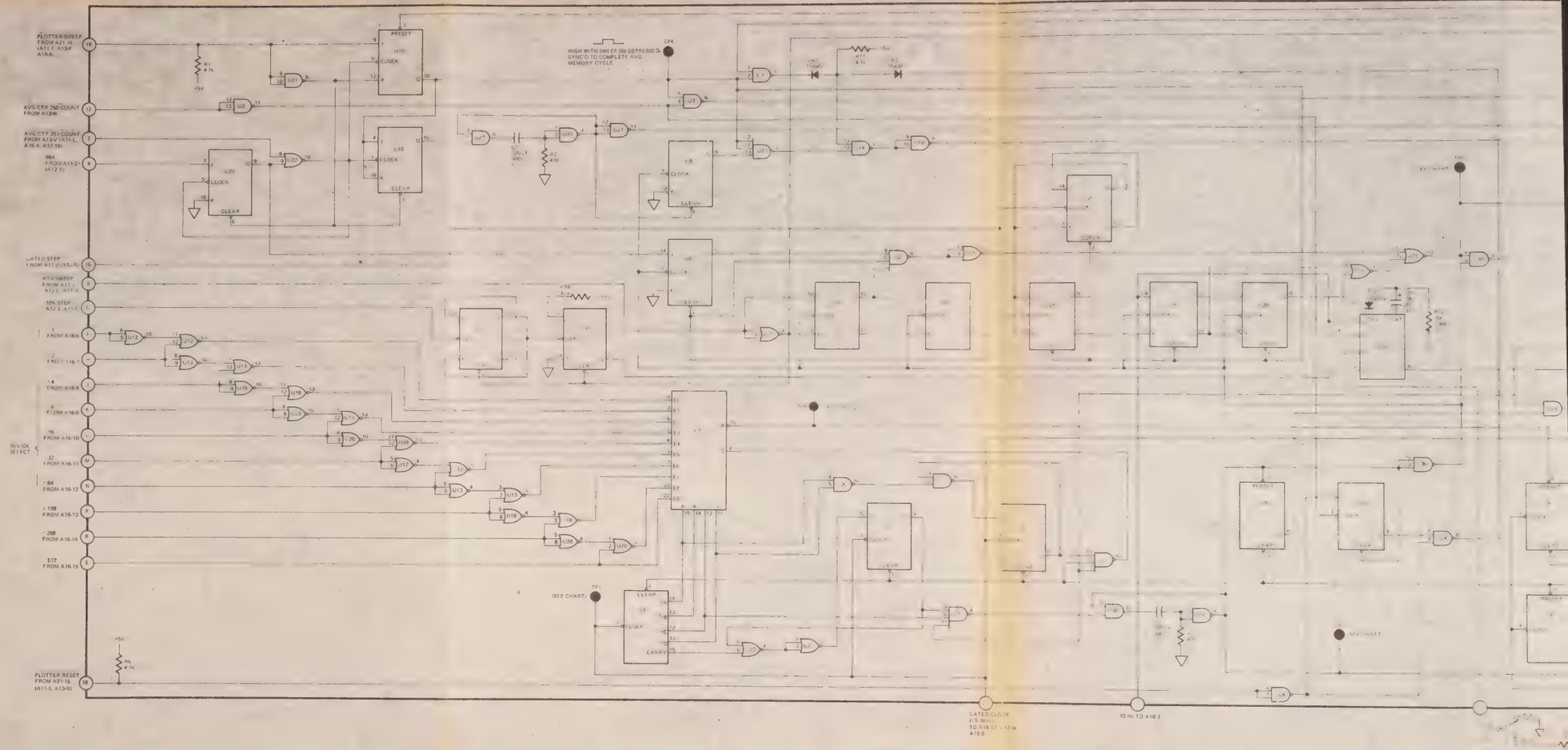
SIZE: D
SCALE: NONE

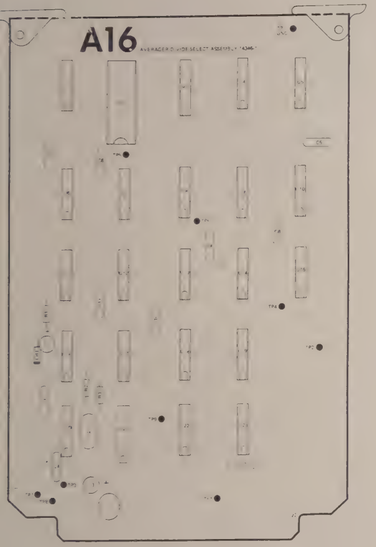

GND A
GND B
TP1
TP2
TP3
TP4
TP5
TP6
TP7
A13
BCD LADDER ASSEMBLY 14336-1

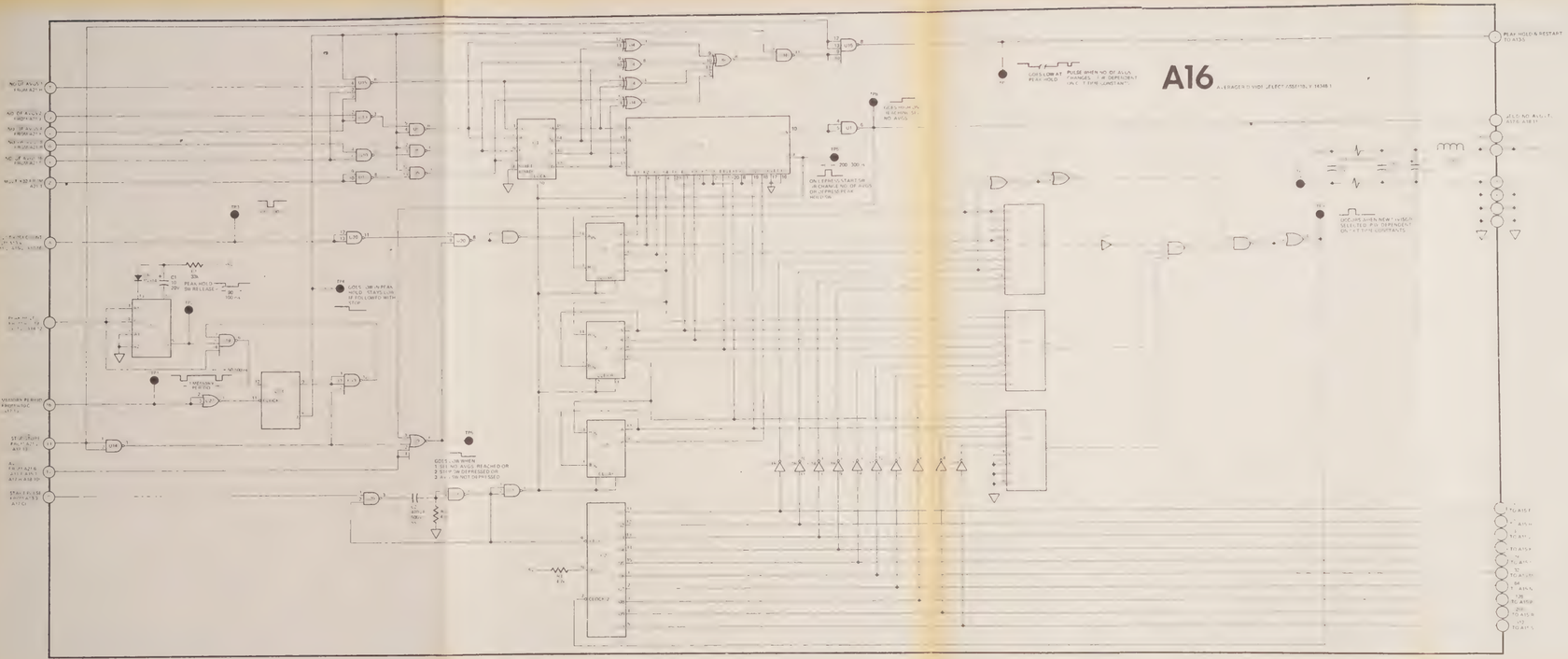

RESET AVG COUNTER FROM A17 F
SYNCD AVG CTR ADV P. LSE FROM A17 J
A/D SAMPLE PULSE FROM A19, (A10 K, A16 K)
SCOPE TRIG FROM A21 J, A11 J2, A31 11
LINES FROM COUNTER
FROM A12 L
FROM A12 M
FROM A12 N
FROM A12 P
FROM A12 R
FROM A12 S
FROM A12 T
FROM A12 U
REFERENCE VOLTAGE = 10 Vdc
TP3
U15 µA741
CR1 IN936A
U7
U3
BASELINE COMP XSTR OUTPUT
GAIN ADJ BITS
OFFSET
+15V
-15V
+5V
DC or FREQ TO R9, A25 E
START TO A21 S, A1

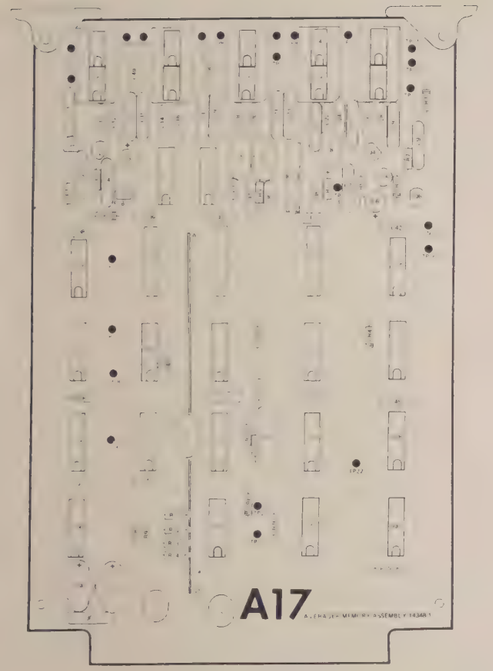

A14

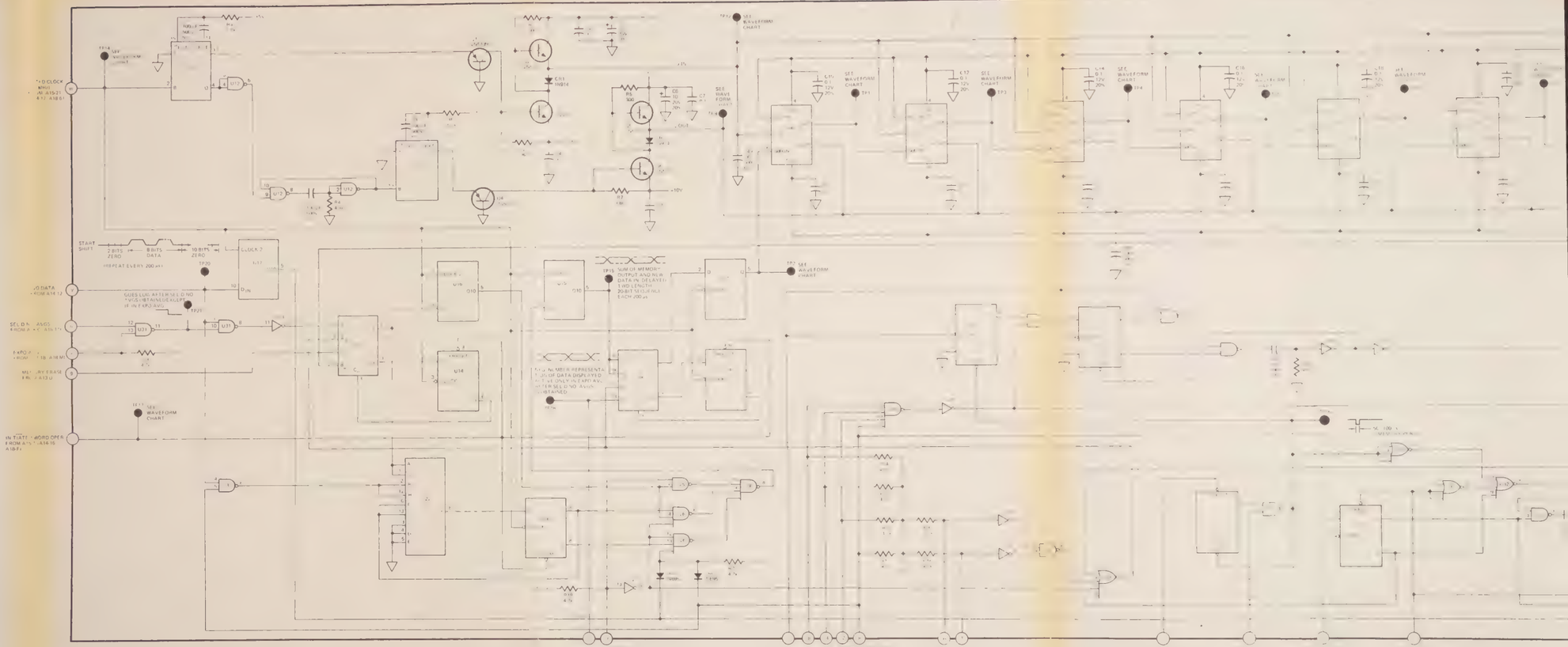

A15
AVERAGER TIMING ASSEMBLY 14342-1

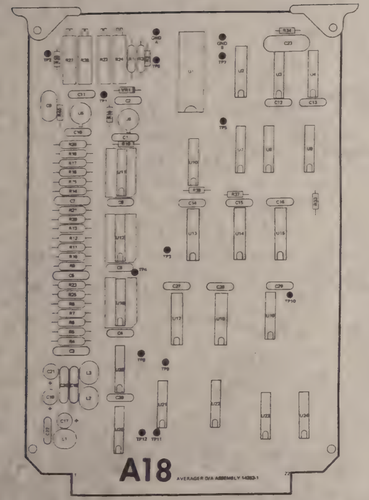

PLOTTER SWEEP FROM A21-16 (A11-7, A13P, A15B)
AVG CTR 256 COUNT FROM A13W
AVG CTR 251 COUNT FROM A13V (A11-L, A15-A, A17-16)
99A FROM A11-21 (A12-Y)
GATED STEP FROM A11-20 (A12-R)
RTA SWEEP FROM A11-2, A12-C, A17-H
10N STEP A12-3, A11-C
1 FROM A16-6
2 FROM A16-7
4 FROM A16-8
8 FROM A16-9
16 FROM A16-10
32 FROM A16-11
64 FROM A16-12
128 FROM A16-13
256 FROM A16-14
512 FROM A16-15
DIVOL SELECT
PLOTTER RESET FROM A21-16 (A11-S, A13-N)
HIGH WITH SWEEP SW DEPRESSED. SYNC'D TO COMPLETE AVG MEMORY CYCLE
PRESET
CLOCK
CLEAR
CARRY
GATED CLOCK 4.5 MHz TO A14-17 + 17-W A18-6
10 Hz TO A18-3



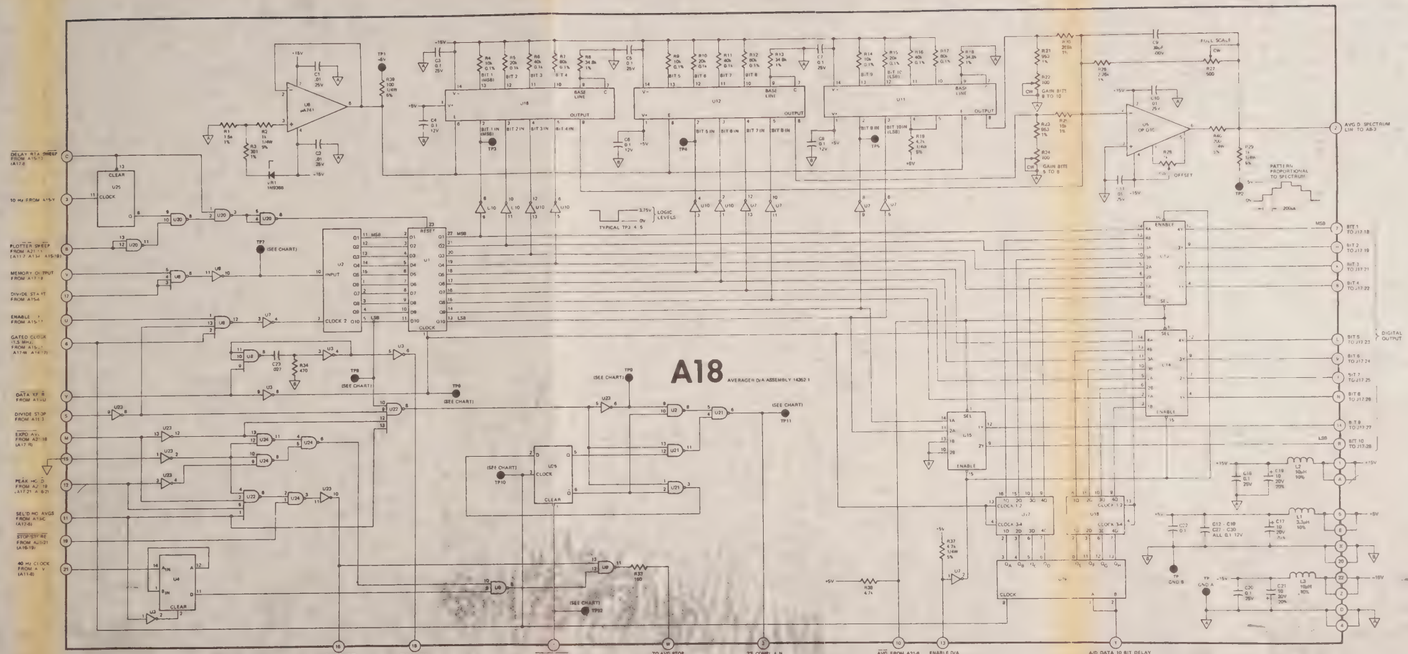

A16
AVERAGER/DIVIDE SELECT ASSEMBLY, Y 14346-1
NO OF AVGS FROM A27
NO OF AVGS FROM A27
NO OF AVGS FROM A27
NO OF AVGS FROM A27
NO OF AVGS FROM A27
MULT AND RESET A27
PEAK HOLD FROM A27
VERNIER PERIOD FROM A27
ST AVGING FROM A27
AVGING FROM A27
START RESET FROM A27
PEAK HOLD & RESTART TO A13
ALSO NO AVGS TO A13, A18
TO A15
TO A27
TO A18
TO A27
TO A18
TO A27
TO A18

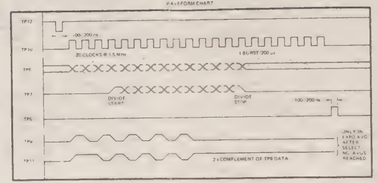

A17





A18 AVERAGER D/A ASSEMBLY 14352-1


DELAY RTN. (MSEC) FROM A15J3 (A17J2)
10 Hz (FROM A15J1)
PLOTTER SPEED FROM A17J1 (A17J7 A15J1 A15J18)
MEMORY OUTPUT FROM A17J8
DIVIDE ST'S +5 FROM A15J4
ENABLE FROM A15J17
GATED CLOCK (1.5 MHz) FROM A15J5 A11J8 (A14J13)
DATA +5 V FROM A15J2
DIVIDE STOP FROM A15J3
EXPO A/D FROM A21J8 (A17J6)
PEAK +C D FROM A21J8 (A17J21 A 6J1)
SELECTED AVGS FROM A15J6 (A17J5)
STOP/START A2 FROM A21J3 (A18J19)
40 Hz CLOCK FROM A15J9 (A11J6)
GATED STOP TO A15J8
WORD SYNC TO J17J9
INITIATE TWO CYCLES FROM A18-7 (A14J16, A17J13)
TO AVG STOP LAMP D24
7'S COMPL + N TO A15J7
AVG FROM A21J8 (A15J12, A15J7, A17J11, A18J17)
ENABLE D/A OUTPUT FROM J17J30
A/D DATA 10 BIT DELAY FROM A17J
AVG D. SPECTRUM LIN TO A8-3
PATTERN PROPORTIONAL TO SPECTRUM
OFFSET
GAIN BITS 0 TO 5
LOGIC LEVELS
TYPICAL TP2, 4, 5
DIGITAL OUTPUT
BIT 1 TO J17J18
BIT 2 TO J17J19
BIT 3 TO J17J21
BIT 4 TO J17J22
BIT 5 TO J17J23
BIT 6 TO J17J24
BIT 7 TO J17J25
BIT 8 TO J17J26
BIT 9 TO J17J27
BIT 10 TO J17J28
GND B



NOTES - UNLESS OTHERWISE INDICATED:

1. (a) RESISTANCE SHOWN IN OHMS.
   (b) RESISTORS 1% AND 0.5% ARE 1/8W.
   (c) CAPACITANCE SHOWN IN MICROFARADS.
   (d) CAPACITORS ARE 12V ±20%, 25V ARE +80% -20%.

INTEGRATED CIRCUITS		PIN NO.		UNUSED GATES/FF
REF. DESIG.	PART NO.	GND	VCC	
U1	74S220N	12	24	NONE
U2	74S27 3N	8	16	NONE
U3-U7, U9-U23	SN74S00N	7	14	NONE
U4	SN74S02N	10	5	NONE
U8	SN74S03N	10	5	NONE
U8, U20, U21, U24	SN74S05N	7	14	SA, 5, 9B
U31, U32	SUBSTITUTE			NONE
U13, U16, U25	SN74S74N	8	16	NONE
U19	SUBSTITUTE			NONE
U17, U18	SN74S74N	12	5	NONE
U19	U26N1684N	7	14	NONE
U22	SN74S08N	7	14	NONE
U25	SN74S74N	7	14	NONE

HIGHEST REF. DESIG. (MSEC)
L30
U1
R47
TP12
U26
V31

REVISIONS						
REV.	ECO	CHG	REVISION	DRAFT	CHK'D	APPD
B	—	011	RETRAIN	R.S.W		
				12-72		

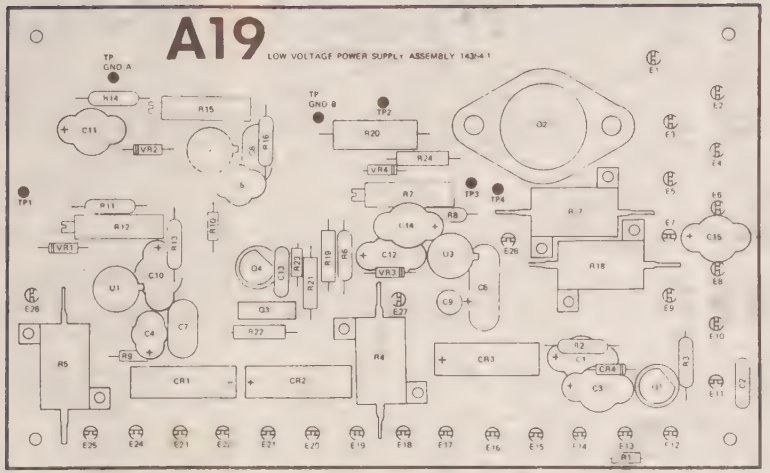
PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing rights in connection therewith are reserved. Because the subject matter was especially planned, it is submitted in confidence for a specified purpose, and the recipient, by accepting this art..., agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, except for the purpose delivered.

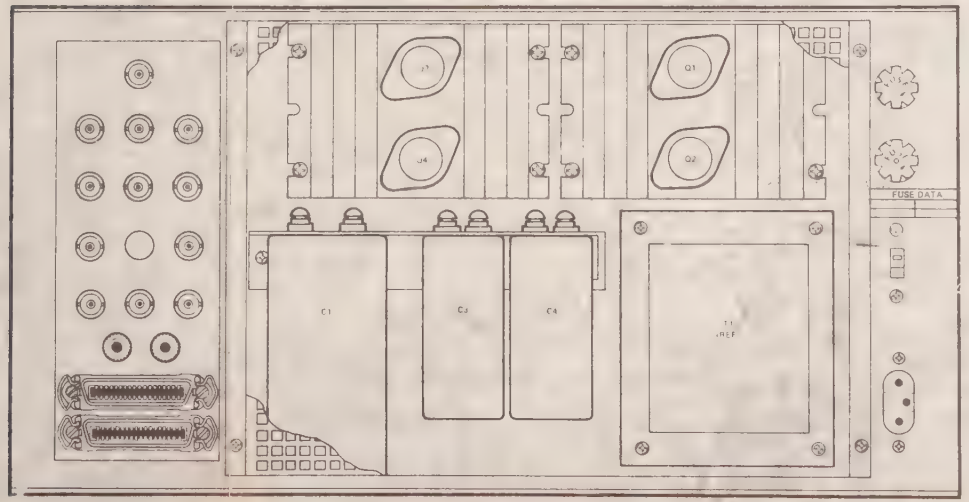
SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

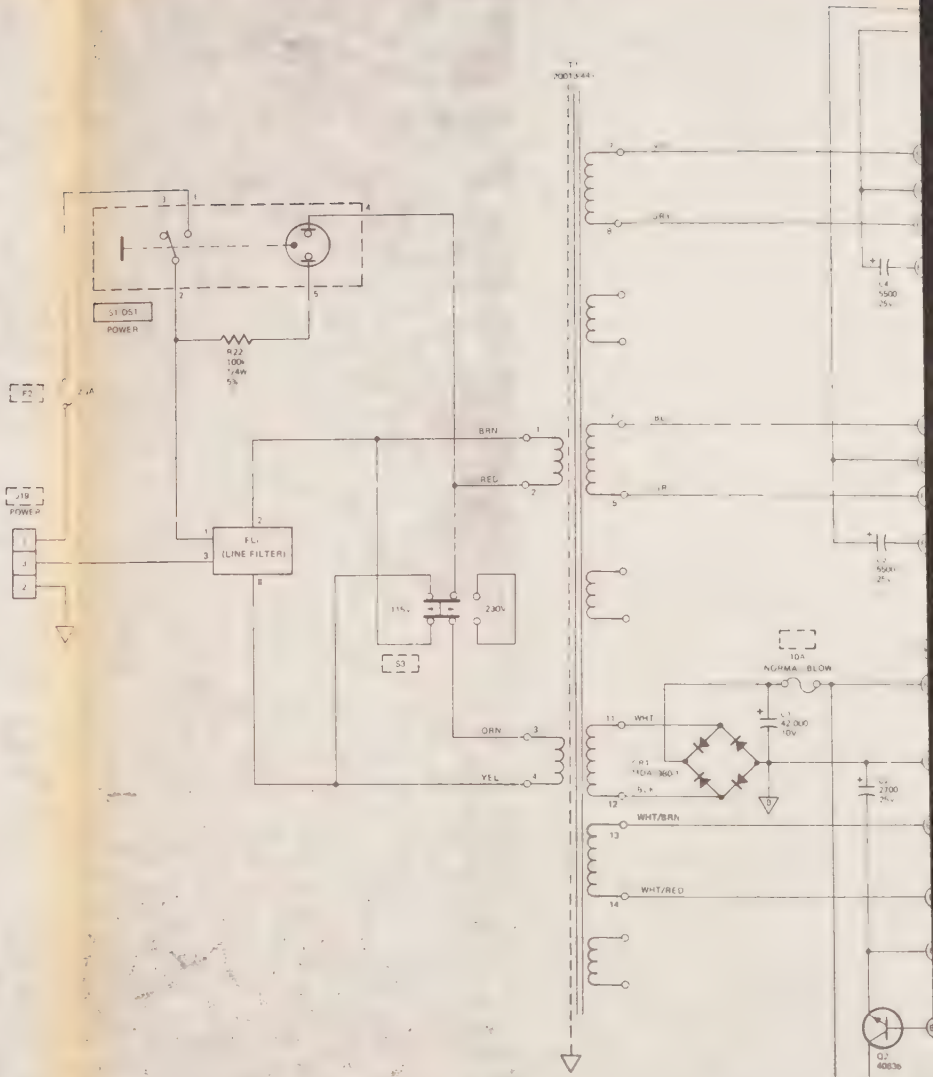
	NAME	DATE
DRAWN	R.S. Nichols	10-72
DESIGNED		
CHECKED		
ENGINEER		
APPROVED		

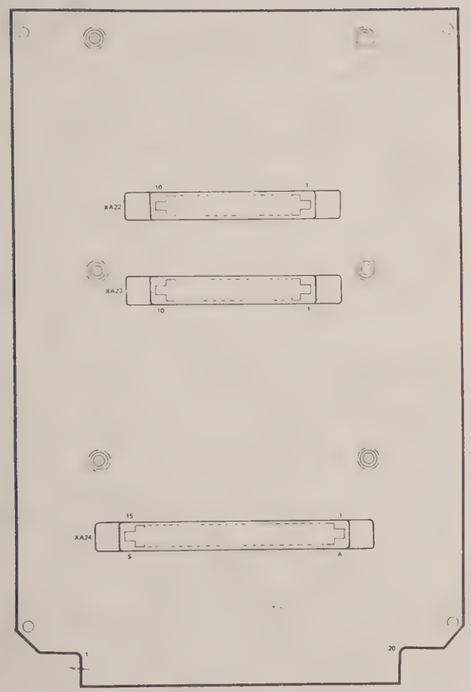
TITLE: SCHEMATIC/COMPONENT LAYOUT AVERAGER D/A ASSEMBLY 14352-1 — A18

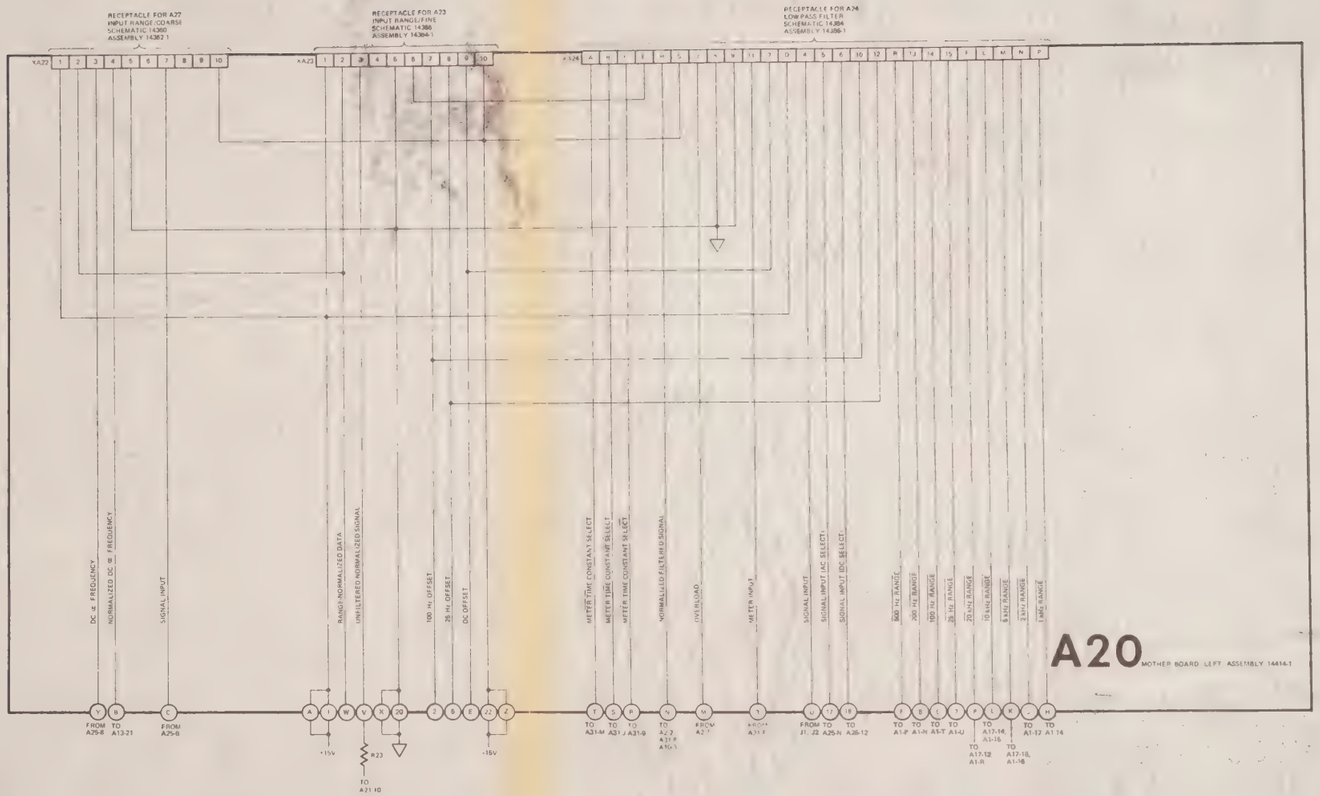
MODEL	SIZE	DRAWING NO.	REV
SD 330		14350	B
SCALE		SHEET	OF


A19
LOW VOLTAGE POWER SUPPLY ASSEMBLY 14364-1
TP GND A
TP GND B
TP1
TP2
TP3
TP4
R14
R15
R16
C11
VR2
R20
R24
VR4
R7
R8
R11
R12
VR1
R13
R10
C10
C4
C7
R9
R5
C14
C12
VR3
R6
R19
R21
R22
C13
Q4
Q3
R27
C9
C6
R4
CR1
CR2
CR3
CR4
R2
C1
C3
R3
Q1
Q2
R17
R18
C15
C2
E1
E2
E3
E4
E5
E6
E7
E8
E9
E10
E11
E12
E13
E14
E15
E16
E17
E18
E19
E20
E21
E22
E23
E24
E25
E26
E27
E28


FUSE DATA
C1
C3
C4
T1
REF


T1
X301-344
ST 051
POWER
R22
100k
1/4W
5%
F2
2A
J19
POWER
F.L.
(LINE FILTER)
BRN
RED
115
230
S3
10A
NORMAL BLOW
C3
42,000
10V
CR1
WHT
ORN
YEL
WHT/BRN
WHT/RED
C4
5500
25v
C5
5500
25v
C2
2700
25v
Q2
40836





REVISIONS						
REV	...	...	...	...	...	...
A	1156	011	REDRAWN	L.S. 12-7-		

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

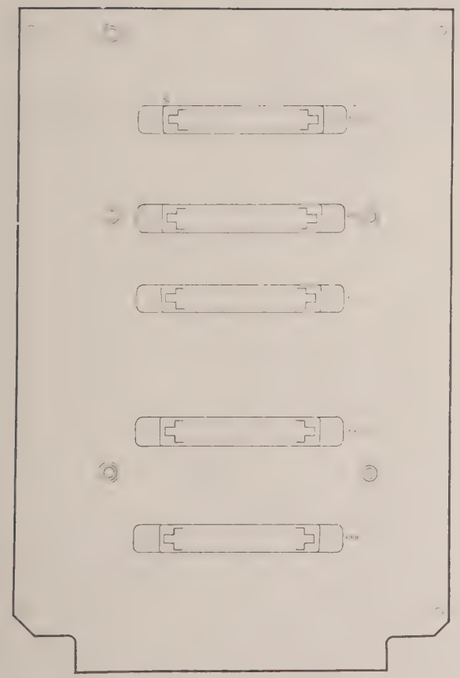
DRAWN	L. SAUER	12-72
DESIGNER		
CHECKED		
ENGINEER		
APPROVED		

TITLE: SCHEMATIC/COMPONENT LAYOUT— MOTHER BOARD, LEFT ASSEMBLY 14414-1

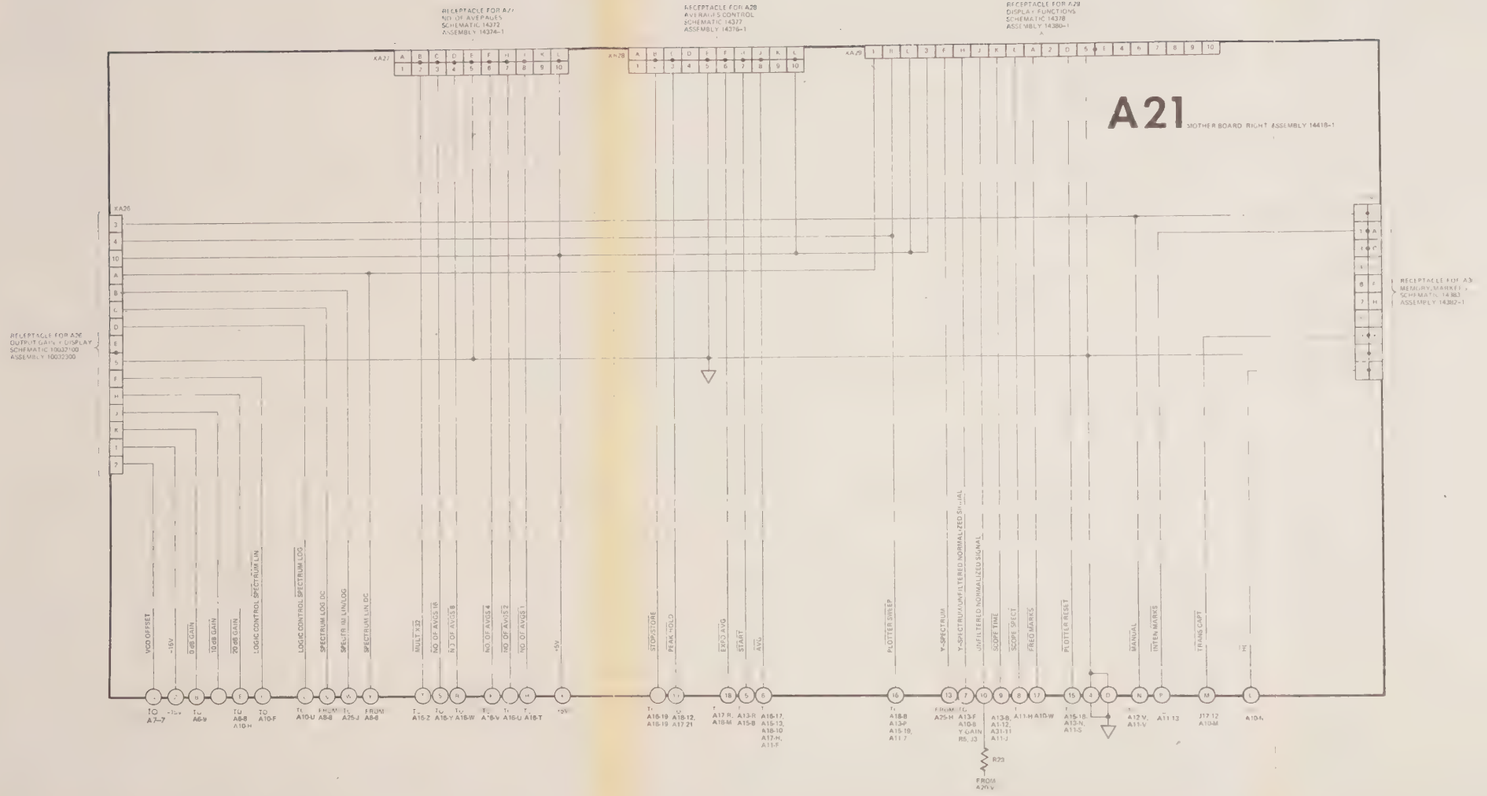
A20

MODEL	SIZE	DRAWING NO	REV
SD330		14415	A

SCALE | SHEET 1 OF 1



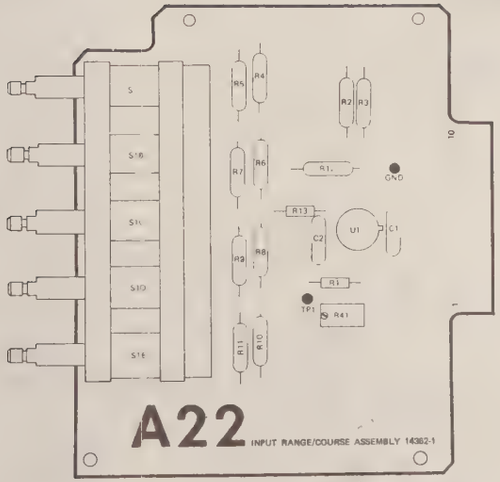
A21 MOTHER BOARD, RIGHT ASSEMBLY 14418-1

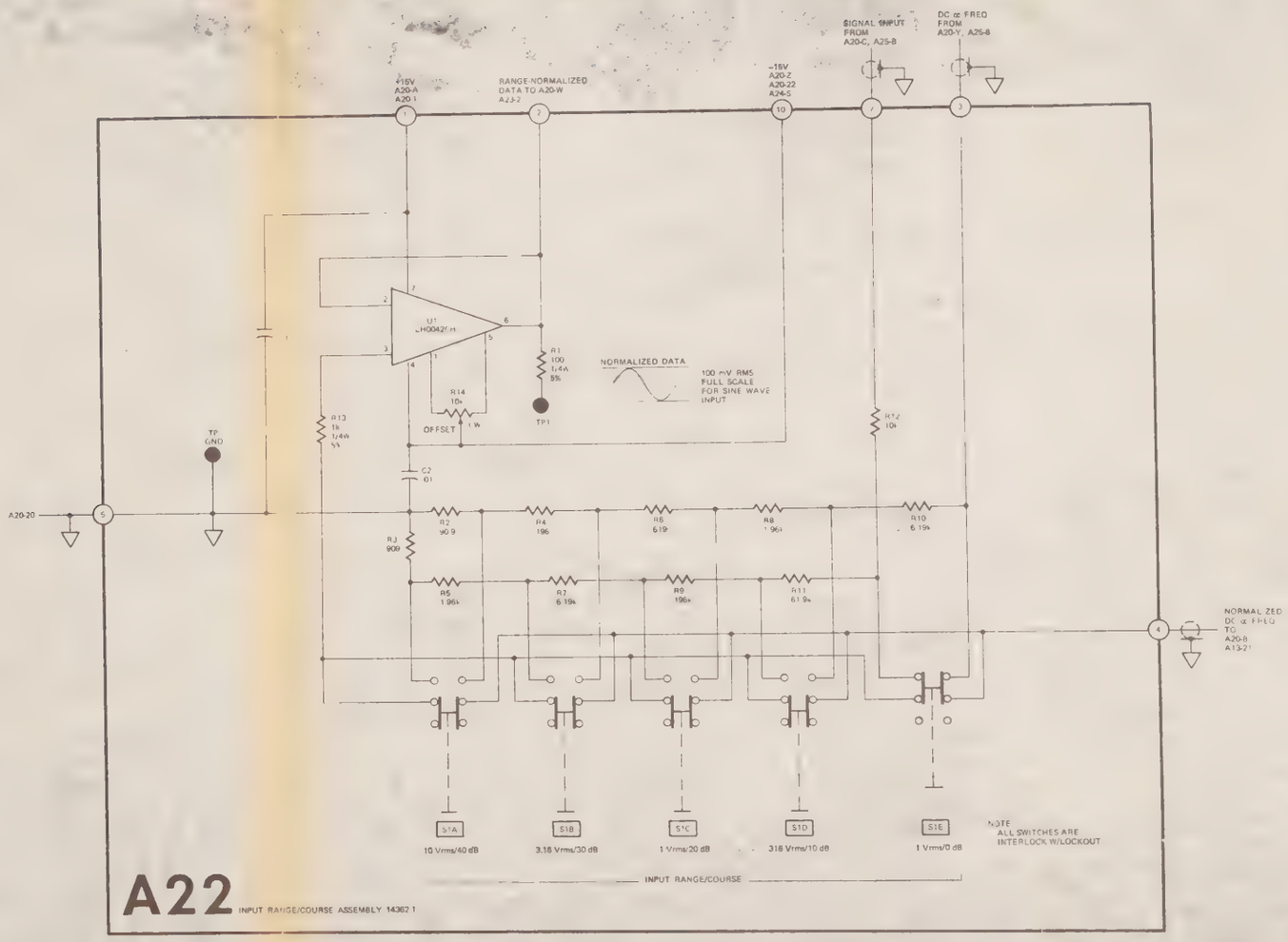


PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION are involved in the subject matter of this material. Manufacturing, reproduction, use, and sales rights pertaining to subject matter are expressly reserved. It is furnished for a specified purpose, and the recipient, by receipt of this material, agrees that this material will not be copied or reproduced in whole or in part, nor made known to any company or person without the prior written consent of Spectral Dynamics Corporation, and that it will be returned upon request or when no longer needed by recipient.

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO			TITLE: SCHEMATIC/COMPONENT LAYOUT MOTHER BOARD, RIGHT ASSEMBLY 14418-1		A21
DRAWN			MODEL SD330	SIZE	DRAWING NO. 14416	REV D
DESIGNED					
CHECKED					
ENGINEER			SCALE		SHEET
APPR. VAL					





REVISIONS						
REV	ECN	S N	DESCRIPTION	DRAFT	CHECK	APPD
A	—	01	REDRAWN	RVM 10-72		

NOTES UNLESS OTHERWISE INDICATED

1. (a) RESISTANCE SHOWN IN OHMS
   (b) RESISTORS ARE 1/8W ±1%
   (c) CAPACITANCE SHOWN IN MICROFARADS.
   (d) CAPACITORS @ 25V +80% - 20%
2. SYMBOL ▭ INDICATES FRONT PANEL LOCATION

HIGHEST REF DESIG USED
C2
R14
S1
TP1
U1

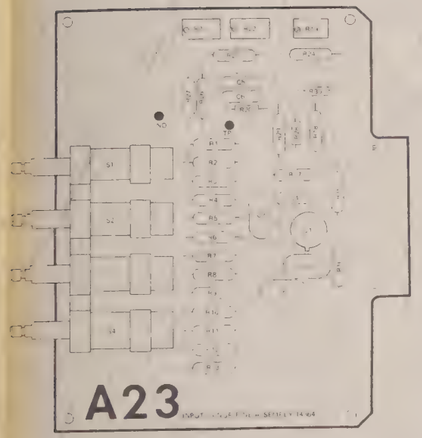
PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all rights in manufacturing, reproduction, use, and sales rights pertaining to the subject matter are expressly reserved. It is submitted to you in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

TITLE: SCHEMATIC/COMPONENT LAYOUT
INPUT RANGE/COURSE
ASSEMBLY 14362-1 A22

DRAWN	R. V. MCCOY	10-72
DESIGNER		
CHECKED		
ENGINEER		
APPROVED		

MODEL	SIZE	DRAWING NO	REV
SD330		14360	A
SCALE		SHEET 1 OF 1	



A23

INPUT RANGE/FINE ASSEMBLY 14364-1

RANGE-NORMALIZED SIG A FROM A20-W

AMPLIFIED DATA 5V pp FULL SCALE FOR SINE WAVE INPUT

TP1

DC OFFSET FROM A20-E A24-7

UNFILTERED NORMALIZED SIGNAL TO A24-E

UNFILTERED NORMALIZED SIGNAL TO A20-V A21-10

+15V A20-1 A20-A

100 Hz OFFSET TO A20-2 A24-10

GND A20-20 A20-X

75 Hz OFFSET TO A20-5 A24-12

S1 1.15

S2 3.45

S3 2.25

S4 1.15

INPUT RANGE (FINE)

REVISIONS						
REV						
A	—	661	RELEASED		3-17	

NOTES: UNLESS OTHERWISE INDICATED

1. (a) RESISTANCE SHOWN IN OHMS
   (b) RESISTORS ARE 1/8W, ±1%
   (c) CAPACITANCE SHOWN IN MICROFARADS
   (d) CAPACITORS ±25V, +80-20%

HIGHEST REF DESIGNATED

R	26
C	8
S	4
TP	1
U	1

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

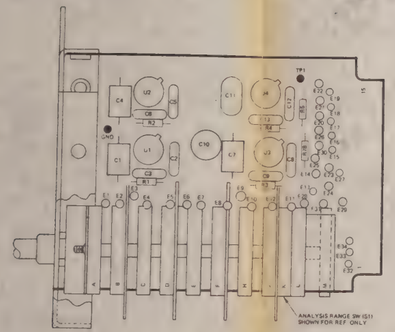
TITLE: SCHEMATIC/COMPONENT LAYOUT — INPUT RANGE/FINE ASSEMBLY 14364-1

A23

DRAWN	L. SAUER	11-72
DESIGNER		
CHECKED		
ENGINEER		
APPROVED		

JOB	SIZE	DRAWING NO	REV
SD330		14365	A

SCALE: | SHEET 1 OF 1



A24A1 LOW PASS FILTER 14386-1

A24A1

LOW PASS FILTER 14386-1

REVISIONS						
REV	ECO	DATE	DESCRIPTION	DRAWN	CHK'D	APP'D
A		011	REDRAWN	L.S. 11-72	-	F.F.

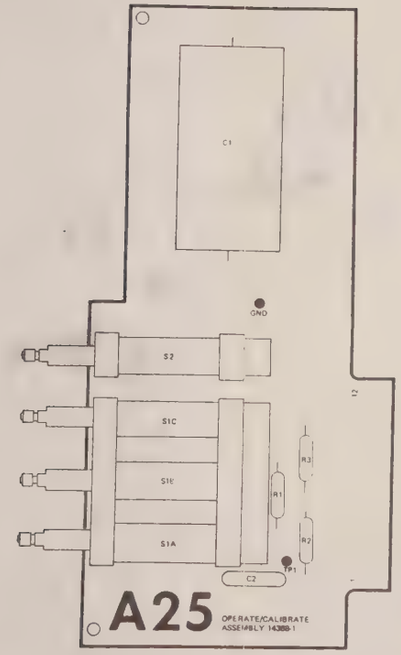
NOTES: UNLESS OTHERWISE INDICATED

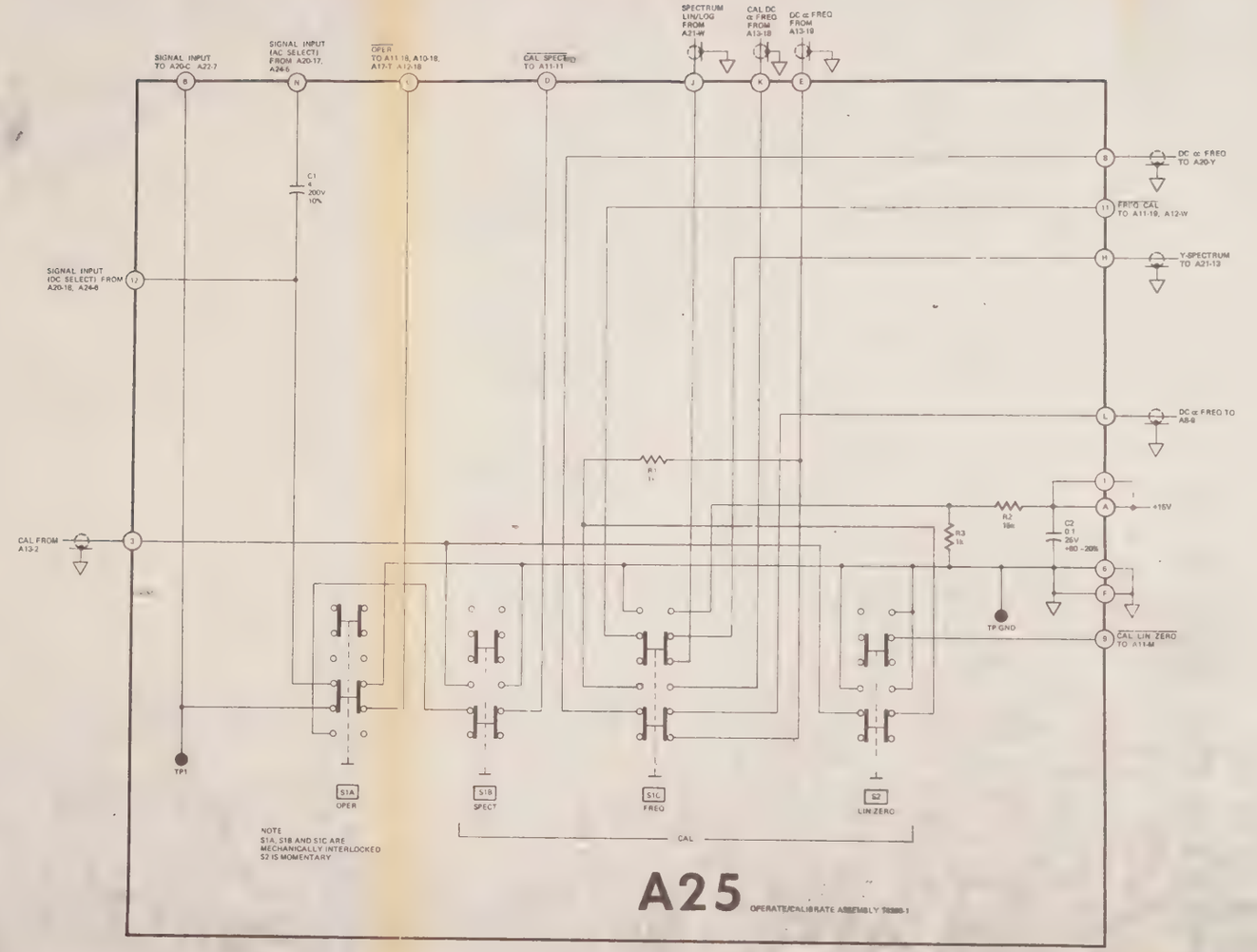
1. (a) RESISTANCE SHOWN IN OHMS
   (b) RESISTORS ARE 1/10W, ±0.1%.
   (c) CAPACITANCE SHOWN IN MICROFARADS.
   (d) CAPACITORS ± 25V, +80-20%.
2. SYMBOL [ ] INDICATES FRONT PANEL LOCATION.

HIGHEST REF DESIG USED
C17
FS2
L34
M1
P78
S2
TP1
U4

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for specific purpose and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO	TITLE: SCHEMATIC/COMPONENT LAYOUT INPUT ASSEMBLY 14816-1		A24
DRAWN: L. SAUER 11-72	MODEL: SD330	SIZE	DRAWING NO: 14384 REV: A
DESIGNED	SCALE		SHEET 1 OF 1
CHECKED			
ENGINEER			
APPROVED			





REVISIONS						
REV	ECO	S/N	DESCRIPTION	DRAFT	CHECK	APPD
A	----	011	REDRAWN	L.S. 11-72		

NOTES UNLESS OTHERWISE INDICATED.

1. (a) RESISTANCE SHOWN IN OHMS
   (b) RESISTORS ARE 1/8W, ±1%.
   (c) CAPACITANCE SHOWN IN MICROFARADS
2. SYMBOL ▭ INDICATES FRONT PANEL LOCATION

HIGHEST REF DESIG USED
C2
R3
TP1
S2

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.

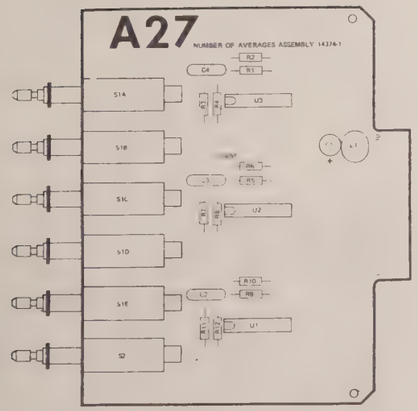
SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

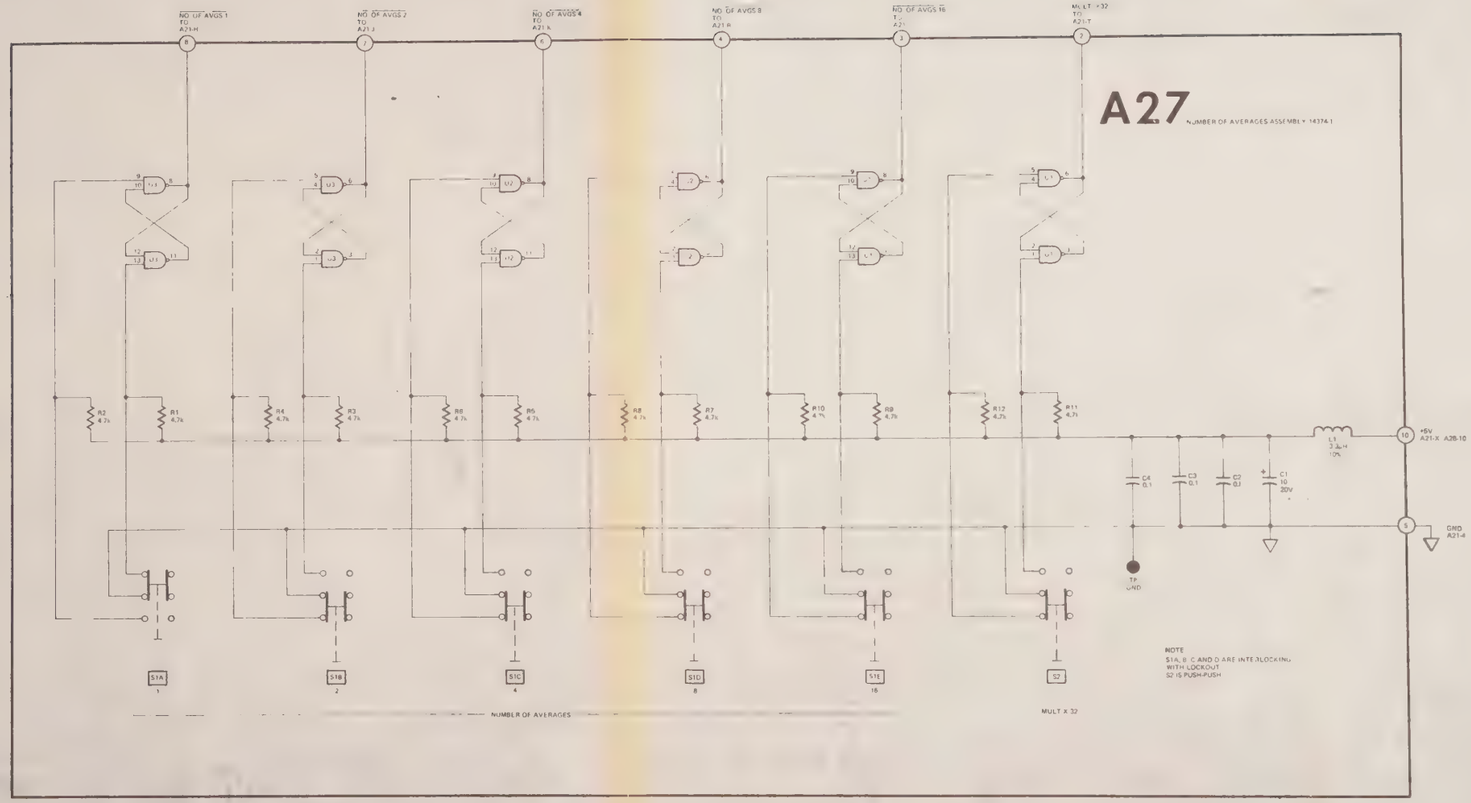
TITLE: SCHEMATIC/COMPONENT LAYOUT OPERATE/CALIBRATE ASSEMBLY 14388-1 — A25

DRAWN	L. SAUER	11-72
DESIGNER		
CHECKED		
ENGINEER		
APPROVED		

MODEL	SIZE	DRAWING NO.	REV
SD330		14366	A

SCALE — SHEET 1 OF 1





REVISIONS

B		011	REDRAWN	LS 2-72	

NOTES: UNLESS OTHERWISE INDICATED
1. RESISTANCE SHOWN IN OHMS.
2. RESISTORS ARE 1/4W ±5%
3. CAPACITANCE SHOWN IN MICROFARADS.
4. CAPACITORS @ 12V ±20%
5. SYMBOL [ ] INDICATES FRONT PANEL LOCATION

INTEGRATED CIRCUITS				
REF. DESIG.	PART NO.	PWR PINS GND	PWR PINS VCC	UNUSED CIRCUITS
U1, U2 & U3	SN7400N	7	14	NONE

HIGHEST REF DESIG USED
U3
S2

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.

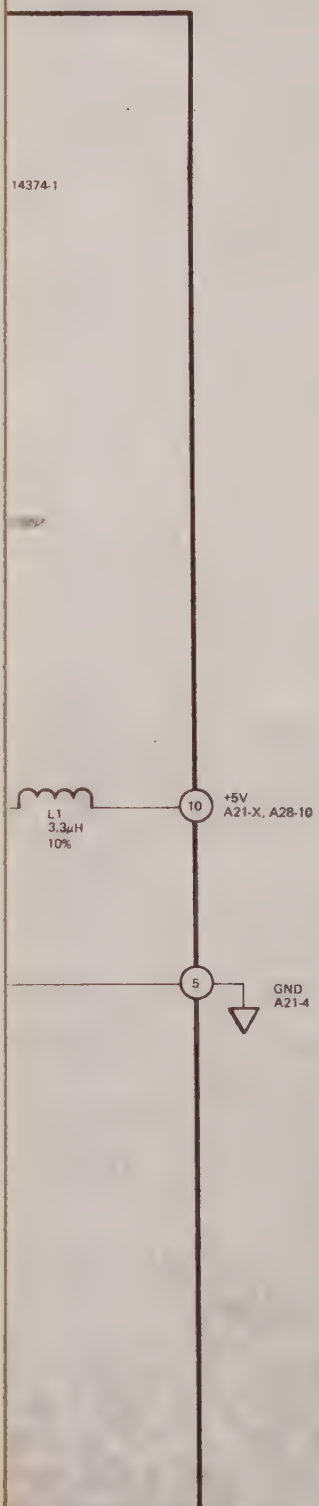
SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

DRAWN	L. SAUER	12-72
DESIGNER		
CHECKED		
ENGINEER		
APPROVED		

TITLE
SCHEMATIC/COMPONENT LAYOUT
NUMBER OF AVERAGES
ASSEMBLY 14374-1
A27

MODEL	SIZE	DRAWING NO	REV
SD330		14372	B
SCALE		SHEET 1 OF	

REVISIONS						
REV	ECO	S/N	DESCRIPTION	DRAFT	CHECK	APPD
B	—	011	REDRAWN	L.S. 12-72		



NOTES: UNLESS OTHERWISE INDICATED

1. (a) RESISTANCE SHOWN IN OHMS.
   (b) RESISTORS ARE 1/4W, ±5%.
   (c) CAPACITANCE SHOWN IN MICROFARADS.
   (d) CAPACITORS @ 12V, ±20%.
2. SYMBOL [ ] INDICATES FRONT PANEL LOCATION.

INTEGRATED CIRCUITS				
REF. DESIG.	PART NO.	PWR PINS GND	PWR PINS VCC	UNUSED CIRCUITS
U1, U2 & U3	SN7400N	7	14	NONE

HIGHEST REF. DESIG. USED
C4
L1
R12
S2
U3

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

DRAWN	L. SAUER	12-72
DESIGNER		
CHECKED		
ENGINEER		
APPROVED		

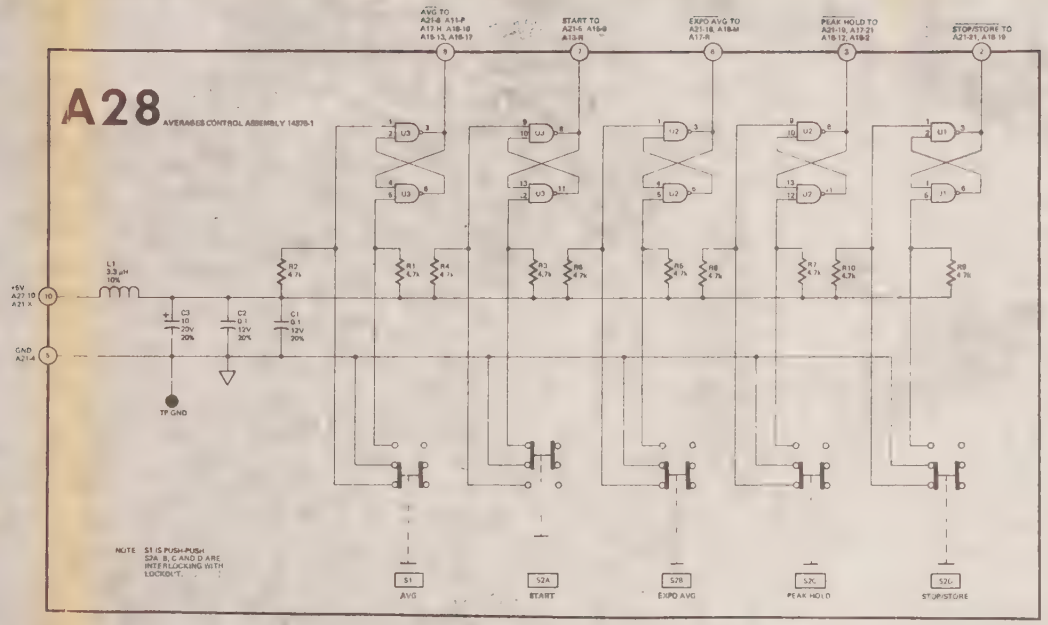
TITLE
SCHEMATIC/COMPONENT LAYOUT - NUMBER OF AVERAGES ASSEMBLY 14374-1

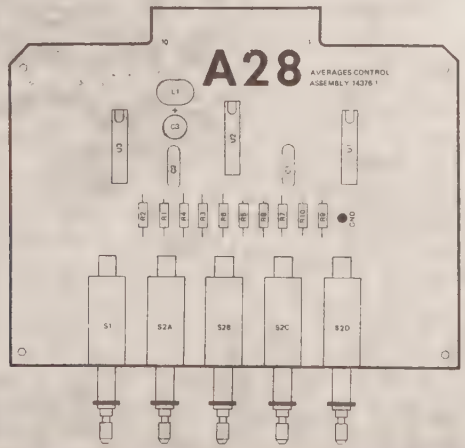
A27

MODEL	SIZE	DRAWING NO.	REV
SD330		14372	B

SCALE

SHEET 1 OF 1





REVISIONS						
REV			DESCRIPTION	DRAFT	MECH	APPD
A	—	001	REDRAWN	RVM 11-72		

NOTES: UNLESS OTHERWISE INDICATED
1. (a) RESISTANCE SHOWN IN OHMS
   (b) RESISTORS ARE 1/4W ±5%
   (c) CAPACITANCE SHOWN IN MICROFARADS
2. SYMBOL ▭ INDICATES FRONT PANEL LOCATION

INTEGRATED CIRCUITS				
		PWR PINS		
REF DESIG	PART NO	GND	VCC	UNUSED CIRCUITS
U1,U2,U3	SN14000N	7	14	U1C U1D

HIGHEST REF DESIG USED
C3
R10
S2
3

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.

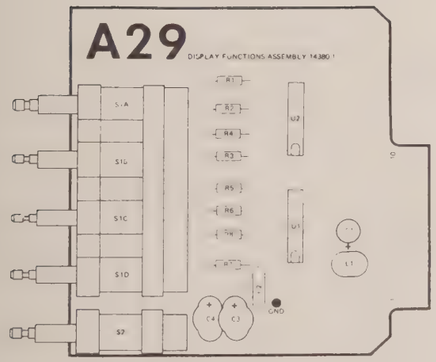
SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

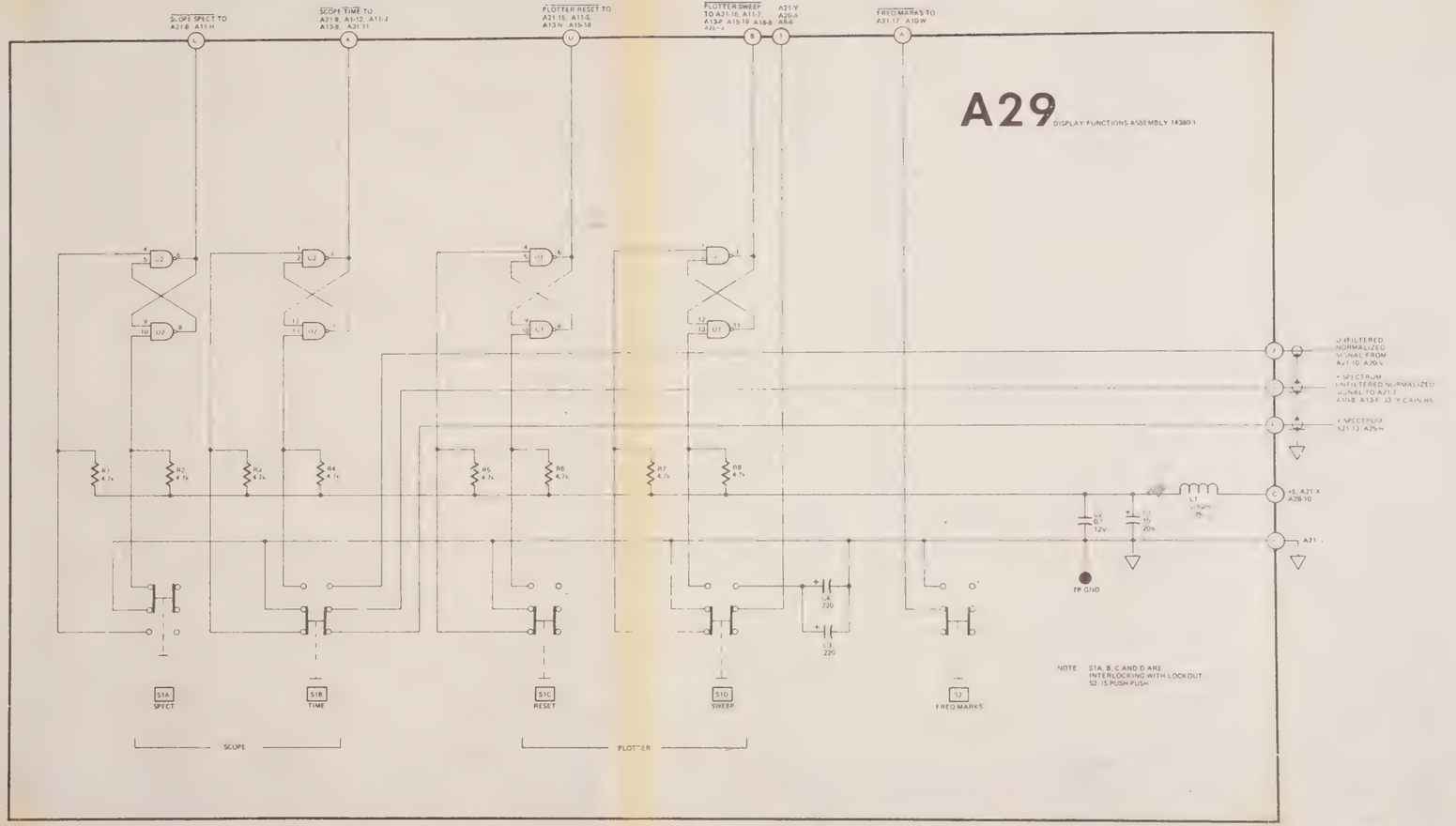
DRAWN	R. V. McCOY	11-72
DESIGNER		
CHECKED		
ENGINEER		
APPROVED		

TITLE: SCHEMATIC/COMPONENT LAYOUT AVERAGES CONTROL ASSEMBLY 14376-1 A28

MODEL	SIZE	DRAWING NO	REV
SD330		14377	A

SCALE | SHEET 1 OF 1





REVISIONS						
REV						
B	—	011	REDRAWN	JWM 12-72		

NOTES

NOTES: UNLESS OTHERWISE INDICATED

1 (a) RESISTANCE SHOWN IN OHMS

(b) RESISTORS ARE 1/4W ±5%

(c) CAPACITANCE SHOWN IN MICROFARADS

(d) CAPACITORS @ 10V ±20%

2 SYMBOL [ ] INDICATES FRONT PANEL LOCATION

INTEGRATED CIRCUITS				
		PWR PINS		UNUSED CIRCUITS
REF DESIG	PART NO.	GND	VCC	
U1 & U2	SN7400N	7	14	NONE

HIGHEST REF DESIG USED
C4
L1
R8
S2
U2

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.

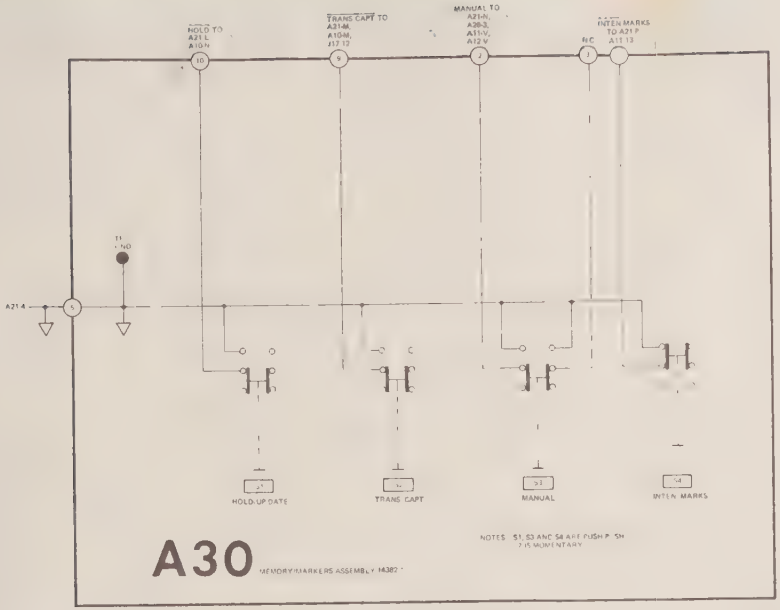
SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

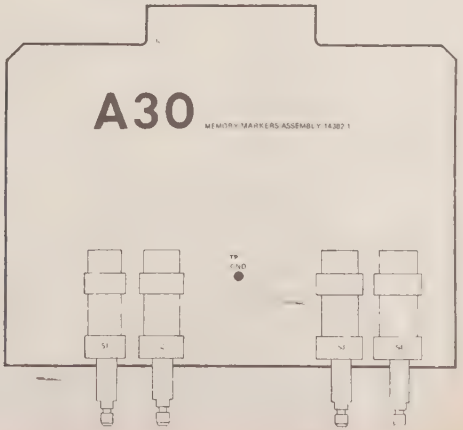
TITLE: SCHEMATIC/COMPONENT LAYOUT DISPLAY FUNCTIONS ASSEMBLY 14380-1 A29

DRAWN	P. V. McCOY	12-72
DESIGNER		
CHECKED		
ENGINEER		
APPROVED		

MODEL	SIZE	DRAWING NO.	REV
SD330		14378	B

SCALE | SHEET 1 OF 1





REVISIONS						
B	—	1				

NOTES: UNLESS OTHERWISE INDICATED
1. SYMBOL ▭ INDICATES FRONT PANEL LOCATION

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered

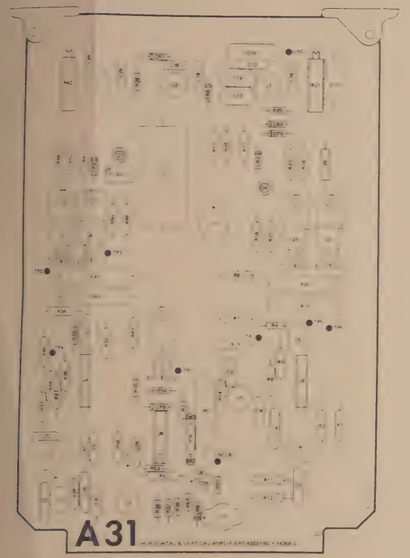
SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

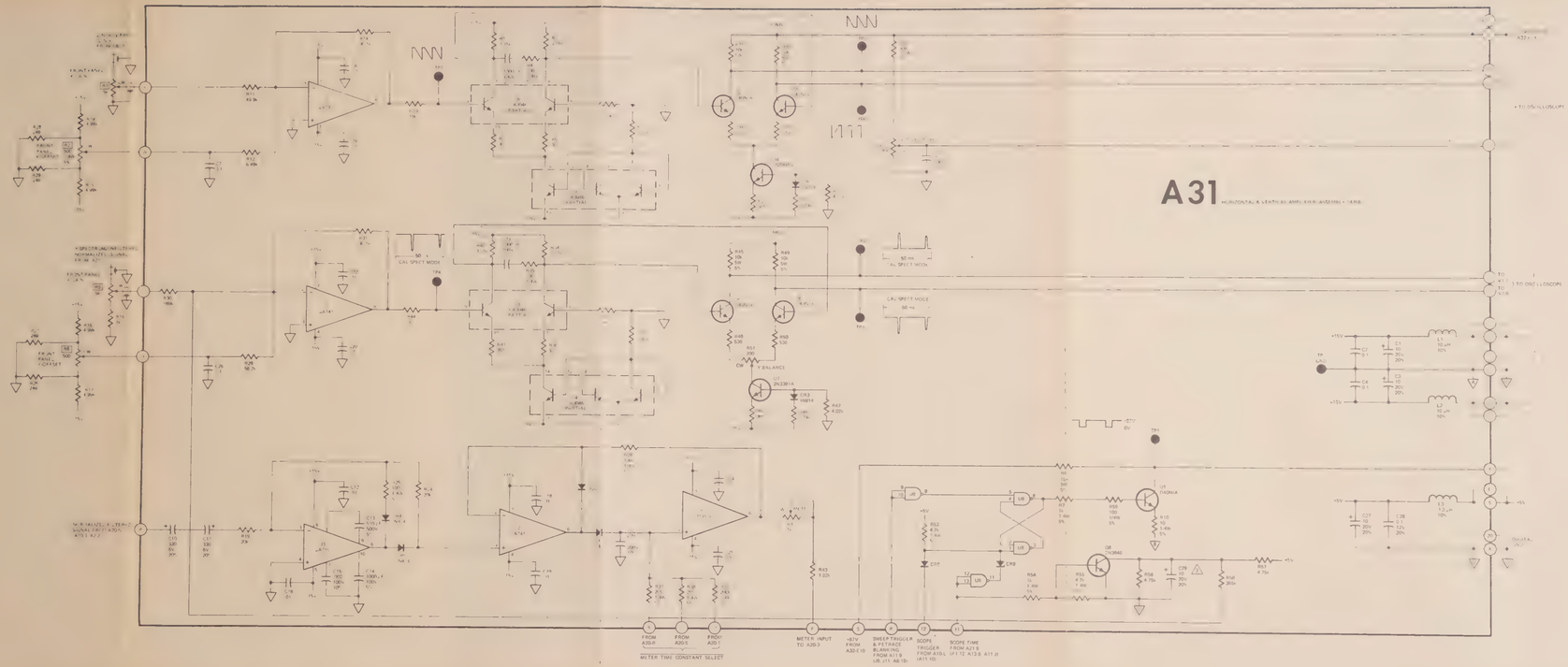
TITLE: SCHEMATIC/COMPONENT LAYOUT MEMORY/MARKERS ASSEMBLY 14382-1 A30

DRAWN	M SLETNAR	11-72
DESIGNER		
CHECKED		
ENGINEER		
APPROVED		

MODEL	SIZE	DRAWING NO	REV
SD330		14383	B

SCALE | SHEET 1 OF 1





REVISIONS

REV	ECN	DESCRIPTION	DATE	APPROVED
A	—	180 REDRAWN	1-3-83	
B	1055	90 R1, 3 WERE IN ROW 2 A20	4-23	
		R1 V R 2 WAS NAP		

NOTES: UNLESS OTHERWISE INDICATED:
1. ALL RESISTANCE SHOWN IN OHMS
2. ALL RESISTORS ARE 1/8W, 5%
3. ALL CAPACITANCE SHOWN IN MICROFARADS
4. ALL CAPACITORS 25V UNLESS OTHERWISE NOTED
5. DIODES ARE TYPE 1N456
6. ⚠ FACTORY SELECT WITH TYPICAL VALUES SHOWN
7. # SYMBOL [ ] INDICATES FRONT PANEL DESIGNATION

INTEGRATED CIRCUITS

REF DESIG	PART NO	GND	VCC	CIRCUIT
U1	SN74V...			

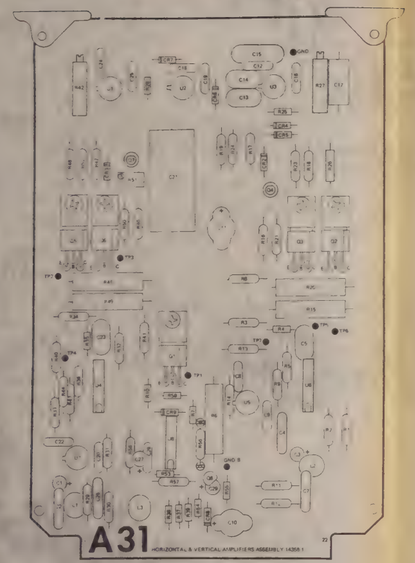
HIGHEST REF DES USED

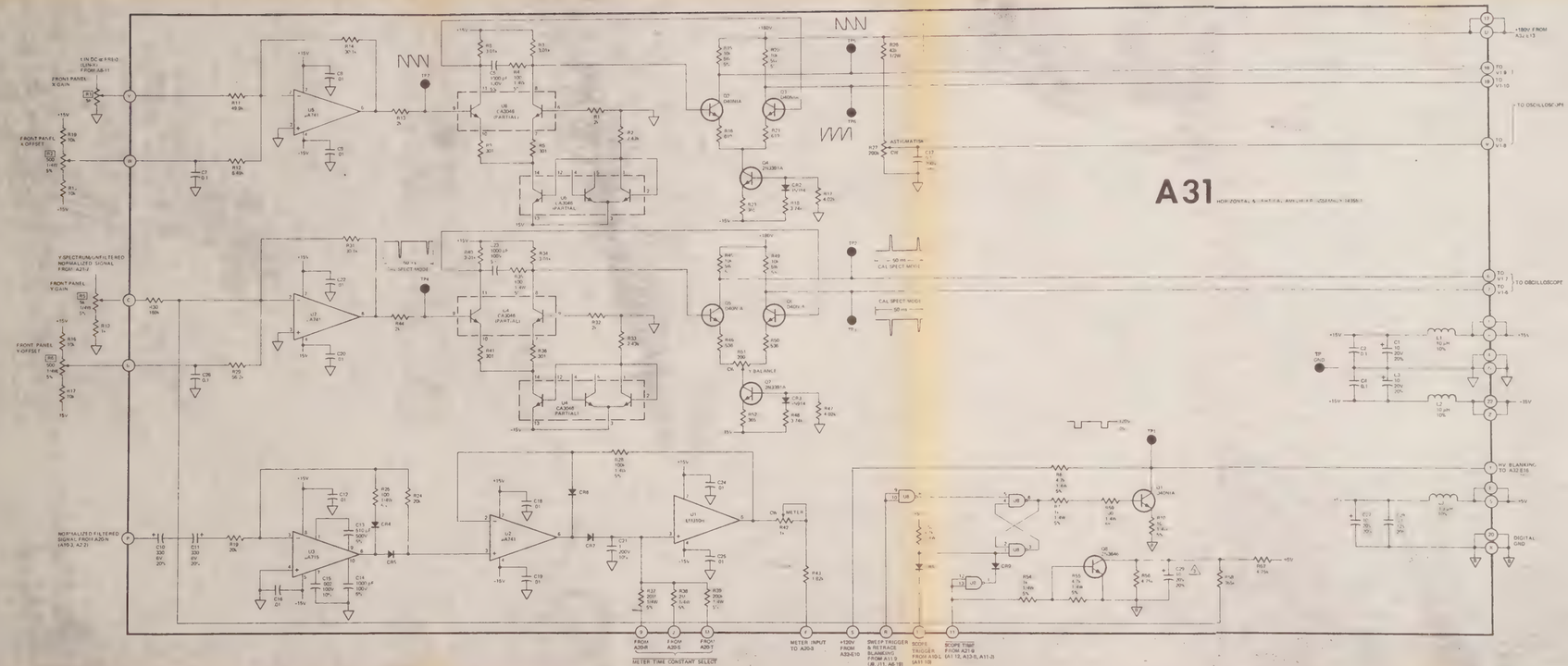
PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material, and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are reserved to Spectral Dynamics Corporation of San Diego. This material is confidential and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose conferred.

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO			
DRAWN	L. SAUER	8-73	
DESIGNED			
CHECKED			
ENGINEER			
APPROVED			

TITLE: SCHEMATIC/COMPONENT LAYOUT
HORIZONTAL & VERTICAL AMPLIFIERS
ASSEMBLY 14358-3 A31

MODEL	SIZE	DRAWING NO	REV
SD330-20		10122100	C
SCALE		SHEET	




A31
HORIZONTAL & VERTICAL AMPLIFIER ASSEMBLY 14358-1
1 MEG DC OFFSET ADJ. FROM A8-11
FRONT PANEL X GAIN
FRONT PANEL X OFFSET
FRONT PANEL Y GAIN
FRONT PANEL Y OFFSET
Y-SPECTRUM/UNFILTERED NORMALIZED SIGNAL FROM A27-J
NORMALIZED FILTERED SIGNAL FROM A26-K (A10-J, A7-J)
CAL SPECT MODE
TO OSCILLOSCOPE
+180V FROM A32-L13
HV BLANKING TO A32-E16
DIGITAL GND
METER TIME CONSTANT SELECT
FROM A20-B
FROM A20-S
FROM A20-T
METER INPUT TO A20-3
+120V FROM A32-E10
SWEEP TRIGGER & RETRACE BLANKING FROM A11-9 (J8, J11, A6-19)
SCOPE TRIGGER FROM A10-L (A11-13, A13-5, A11-J1)

REVISIONS						
REV	ECN	DATE	DESCRIPTION	DRAWN	CHECKED	APPROVED
S		011	REDRAWN	A 12-72		

NOTES UNLESS OTHERWISE INDICATED
1. (a) RESISTANCE SHOWN IN OHMS
   (b) RESISTORS ARE ±10% ±1%
   (d) CAPACITANCE SHOWN IN MICROFARADS
   (e) CAPACITORS @ 25V -80 -20%
2. DIODES ARE TYPE 1N695
3. FACTORY ADJUST WITH OPTIMUM VALUE SHOWN.
4. SYMBOL ▭ INDICATES FRONT PANEL LOCATION.

INTEGRATED CIRCUITS

REF.DES.†	PART NO.	PWR.PINS GND	VCC	UNUSED CIRCUITS
U1	SN7400N	7	14	NONE

MILSHEET REF. DESIG. USED
U1
U2
U3
U4
U5
U6
U7
U8

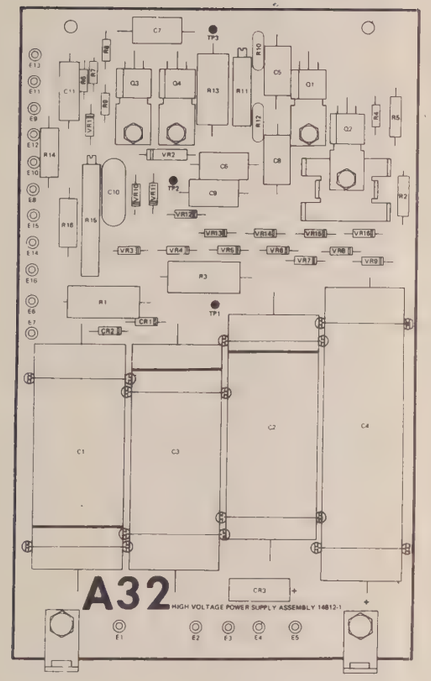
PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are expressly reserved. This material is submitted to confidence for a specified purpose, and the user, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered.

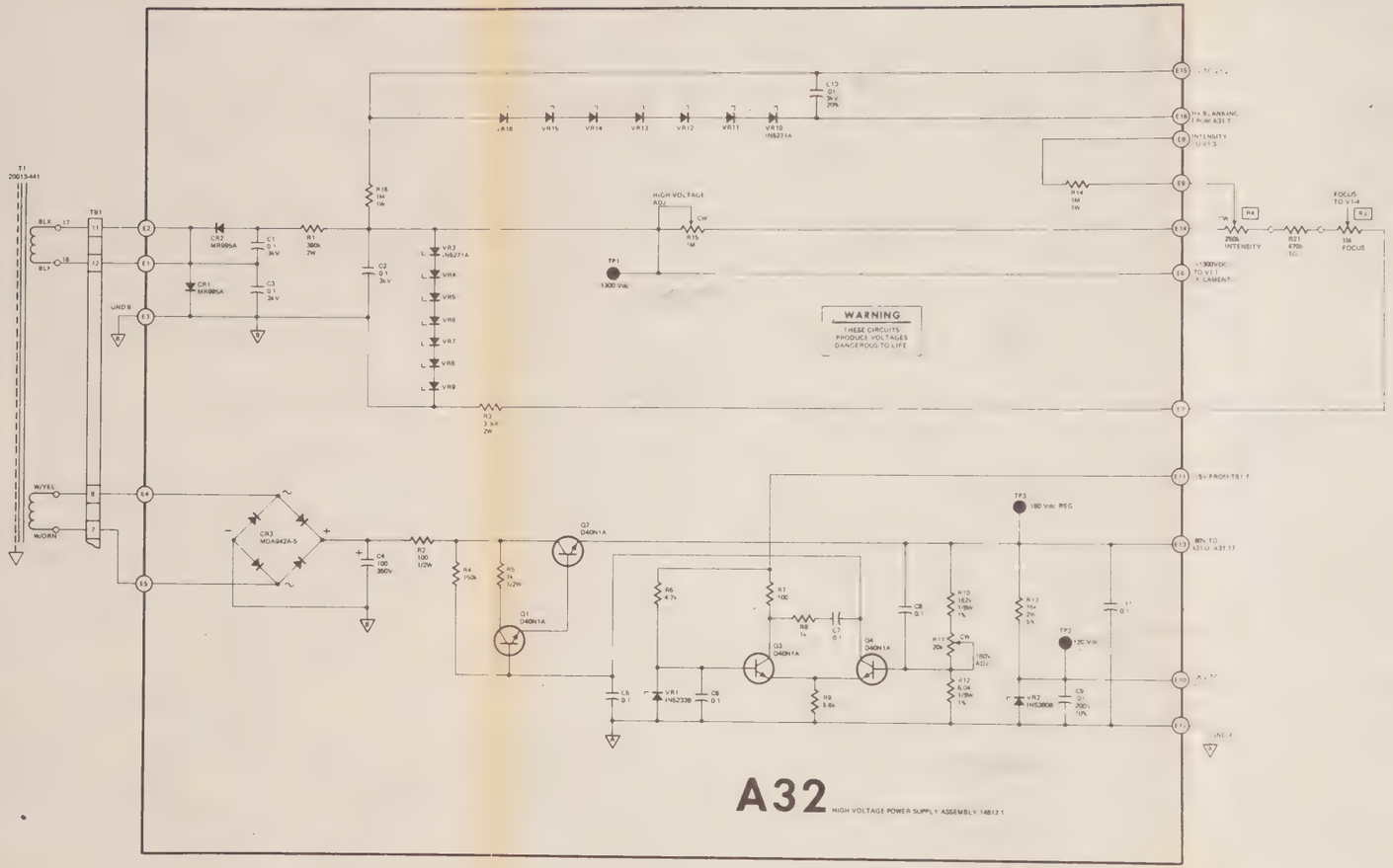
SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

TITLE: SCHEMATIC/COMPONENT LAYOUT
HORIZONTAL & VERTICAL AMPLIFIER
ASSEMBLY 14358-1

DRAWN	C. SAUER	12-72	MODEL	SIZE	DRAWING NO.
DESIGNED			SD330		14359
CHECKED					
ENGINEER			SCALE		
APPROVED					

A31 REV B
SHEET 1 OF 1





REVISIONS						
REV	ECO	S/N	DESCRIPTION	DRAFT	CHECK	APPD
E	—	011	REDRAWN	L.S. 12-72		
F	1474	011	C8 WAS 1μF & R13 WAS 4.7k	UBC 5-73		

NOTES UNLESS OTHERWISE INDICATED
1. (a) RESISTANCE SHOWN IN OHMS
   (b) RESISTORS ARE 1/4W ±5%
   (c) CAPACITANCE SHOWN IN MICROFARADS
   (d) CAPACITORS @ 200V ±10%
2. DIODES ARE TYPE IN5281A
3. SYMBOL ☐ INDICATES FRONT PANEL LOCATION

HIGHEST REF DESIG USED
C11
CR3
E16
J4
R18
TP3
VR18

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO are involved in the subject matter of this material and all manufacturing, reproduction, use, and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient, by accepting this material, agrees that this material will not be used, copied or reproduced in whole or in part, nor its contents revealed in any manner, or to any person, except for the purpose delivered

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

DRAWN	L. SAUER	12-72
DESIGNER		
CHECKED		
ENGINEER		
APPROVED		

TITLE: SCHEMATIC/COMPONENT LAYOUT HIGH VOLTAGE POWER SUPPLY ASSEMBLY 14812-1 A32

MFG'G	SIZE	DRAWING NO	REV
SD330		14813	F

SCALE — SHEET OF

SD330 SPECTRASCOPE REAL TIME ANALYZER

APPLICATIONS

- VIBRATION MONITORING
- PSD ANALYSIS
- NOISE STUDIES
- "DRIVE-BY" TESTING
- TRANSIENT SPECTRUM DISPLAYS
- SPEECH ANALYSIS
- COMMUNICATIONS MONITORING
- MACHINERY DIAGNOSIS
- AMPLITUDE VS FREQUENCY VS TIME STUDIES
- "SIGNATURE" DETERMINATION

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO
POST OFFICE BOX 671, SAN DIEGO, CALIFORNIA 92112
TELEPHONE 714—278-2501 • TWX 910-335-2022

SD330 SPECTRASCOPE™

GENERAL DESCRIPTION

The Spectrascope Real Time Analyzer is a stand-alone unit which serves several important functions. Raw data waveforms are first displayed on the built-in oscilloscope. This gives indications of correct bias voltages, gross data values, possible clipping, etc. Selection may then be made to observe the narrowband real time spectrum of the signal input. The internal display presents a spectrum in terms of linear frequency versus either linear or logarithmic amplitude as selected. The frequency resolution is equivalent to 250 parallel filters. If noisy signals or signals whose spectrum value fluctuates with time are under investigation, Averaging of successive spectra can be performed. Either a selected number of spectra can be chosen for observation (for example, 32 averages) or running (exponential) averaging may be selected. In the exponential mode, the analyzer continuously averages the spectrum values with the pre-selected "time constant." A Peak Hold mode of operation automatically stores the highest spectrum values that exist in each filter location over a selected time period. In addition to the internal scope display, X and Y outputs are made available for external monitoring or X-Y recording. As a standard feature, parallel binary words proportional to spectrum data amplitudes are available at a rear connector.

The Spectrascope Real Time Analyzer is a hybrid instrument operating on the time-compression principle. Once the frequency range and amplitude scaling have been chosen, data is passed through an anti-aliasing filter. Analog-to-digital conversion is then performed and digital data samples stored in a high-speed recirculating memory. After speedup to a fixed recirculation rate, the data is converted back to an analog signal and a swept spectrum analysis performed. Whether data is observed in a Real Time mode or a selected number of averages is taken, an adjustable intensity marker permits rapid identification of any point in the spectrum within 1 filter resolution element.

The Spectrascope Real Time Analyzer is a complete stand-alone, self-contained monitor and analyzer. It will accept signal inputs either from tape recorded data or directly on-line from conditioned accelerometers, microphones, velocity pickups, etc.

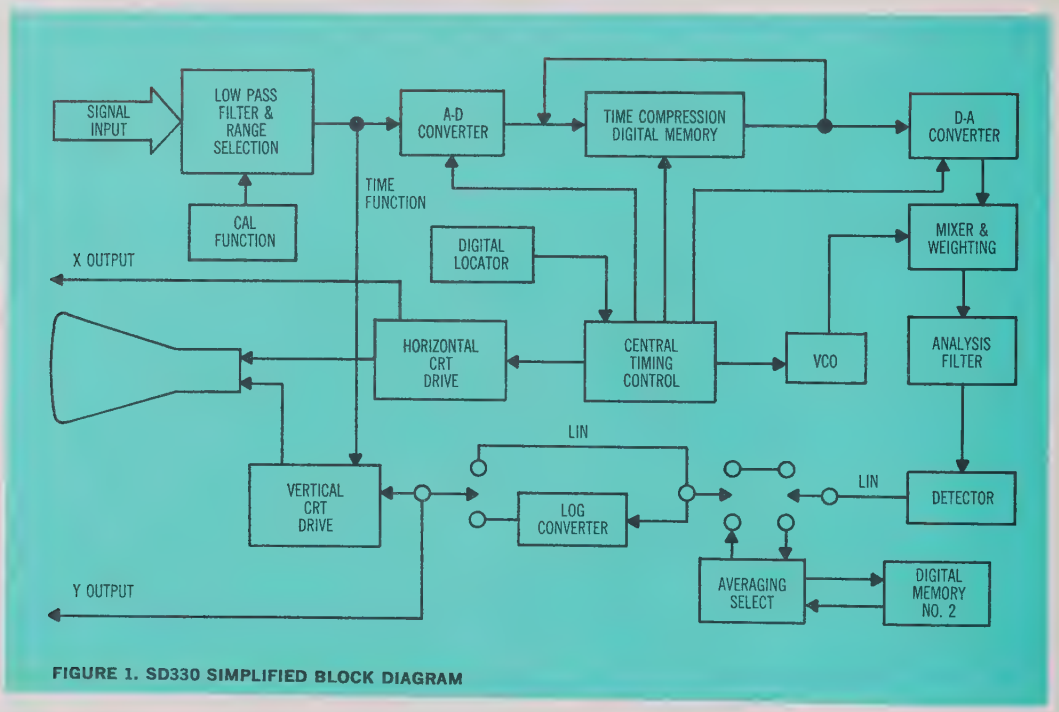


FIGURE 1. SD330 SIMPLIFIED BLOCK DIAGRAM

FEATURES:

- 250 "line" Spectrum Analysis
- Built-in flicker-free display—20 analyses per second
- 0.15 Hz to 20 kHz operation (to 1,200,000 rpm)
- Time history display
- Built-in spectrum averaging
- Linear and Log Spectrum displays
- "Peak Hold" feature for non-stationary responses
- Exponential averaging for continuously calibrated displays
- Adjustable transient capture for impact signals
- Analog and digital outputs
- Display rates compatible with standard scopes and plotters
- Expandable for Signature or "Zoom-in" analysis with standard accessories
- Intensified "dot" marks real time or averaged spectrum locations

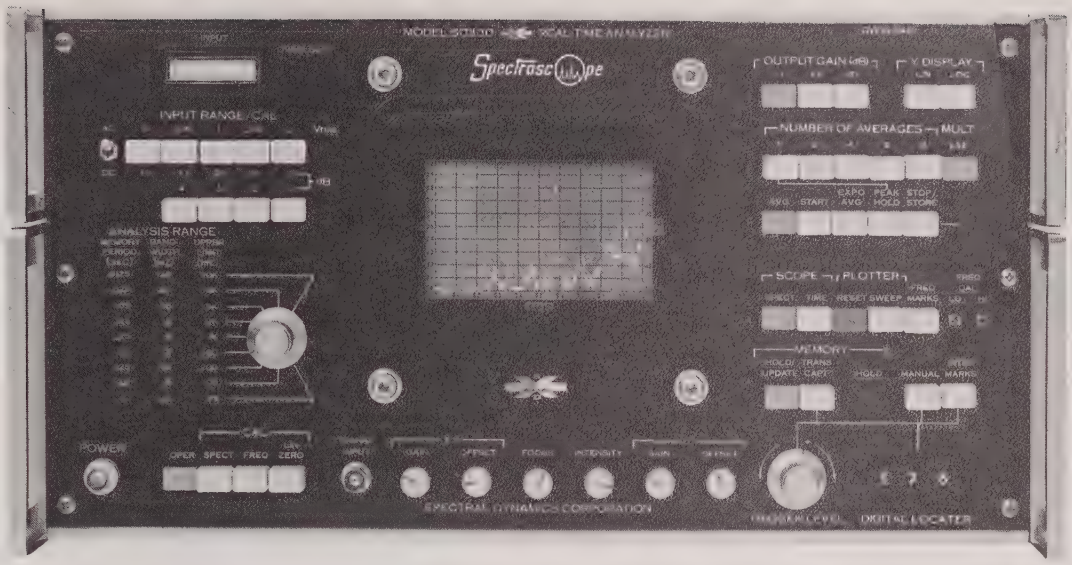
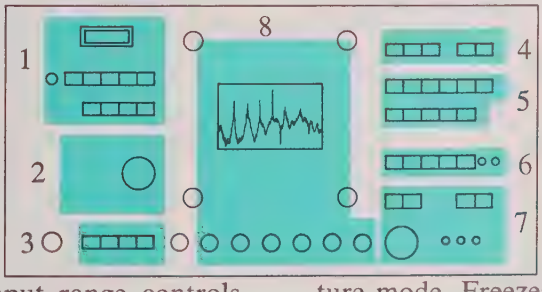


FIGURE 2. SD330 SPECTRASCOPE™ REAL TIME ANALYZER

1. Input level selection and monitor—Selects AC/DC coupling and input signal range. Adjustable in 1 dB steps from 100 mV rms full scale to 31.6 V rms full scale.
2. Analysis frequency range—Selects upper frequency, filter bandwidth, memory period and anti-aliasing filter with single switch selection (see Table I). Analysis range control also serves as time base selector for observing time waveforms. External sampling input available in rear.
3. Calibration — Simple push-button controls for setting of X and Y axes of either built-in or external displays. Used in conjunction with input range controls.
4. Output Gain/Y Display—Selects "post filter" gain prior to averaging; selects LIN or LOG spectrum display of real time or averaged spectrum values.
5. Ensemble Averaging Section—Engages spectrum averager if desired; selects mode of averaging and number of spectra to be averaged.
   In PEAK HOLD or EXPO AVG modes, a flashing red light tells operator if new data is being accepted. If averaged data has been "frozen" in memory, or if selected number of Linear averages is completed, light gives steady indication.
6. SCOPE/PLOTTER mode select—Controls type of display, initiates plotter sweep, engages internal crystal frequency markers and provides simple internal frequency cal.
7. Memory Control, Trigger Level, Intensity Marker and Digital Locater—Used to set trigger for time function display and Transient Capture mode. Freezes data in memory for repeated spectrum display. Selects location for intensifying spectrum points and permits manual scan of spectrum.
8. Controls for built-in scope display—Focus, Intensity and X and Y axis Gain and Offset.



ANALYZER RANGE/TIME BASE PARAMETERS

Analysis Range (Hz)	Memory Period (Sec)	Filter Spacing (Hz)	3 dB Filter Bandwidth (Hz)	Noise Filter Bandwidth (Nominal) (Hz)	Spect Mode Calibration Frequency (Hz)	Time Mode Calibration Signal		
						Frequency (Hz)	Period (mSec.)	Period Per 1/10 Spect (*mSec.)
20k	0.0125	80	120	132	6k	5k	0.2	0.1667
10k	0.025	40	60	66	3k	2.5k	0.4	0.333
5k	0.05	20	30	33	1.5k	1.25k	0.8	0.666
2k	0.125	8	12	13.2	600	500	2	1.67
1k	0.25	4	6	6.6	300	250	4	3.33
500	0.5	2	3	3.3	150	125	8	6.67
200	1.25	0.8	1.2	1.32	60	50	20	16.67
100	2.5	0.4	0.6	0.66	30	25	40	33.3
25	10	0.1	0.15	0.16	7.5	6.25	160	133.3

*One division of display calibrated for frequency in SPECT mode

TABLE I. FREQUENCY RANGE AND OTHER DATA

TYPICAL OPERATIONS

FIRST: View the Raw Data Signal

As a first step toward complete signal monitoring, the raw signal input (perhaps from a vibration transducer or microphone) is viewed on the oscilloscope in the TIME mode. In general, it is good practice to view the overall time waveform on an oscilloscope prior to performing a spectrum analysis. In some cases, transducer limiting or amplifier overloading may produce clipped signals which, when analyzed, produce spectrum components unrelated to the data. Using selectable a-c/d-c coupling, the overall data magnitude and possible bias offset are quickly established. In this way, any transducer or signal conditioning problems can be quickly determined and corrections made before continuing with the analysis. Calibration of the time axis is accomplished by using the X-axis gain control. The calibration frequencies that correspond to the range switch positions are listed in Table I. Triggering of the time function display is accomplished using the front panel TRIGGER LEVEL adjustment.

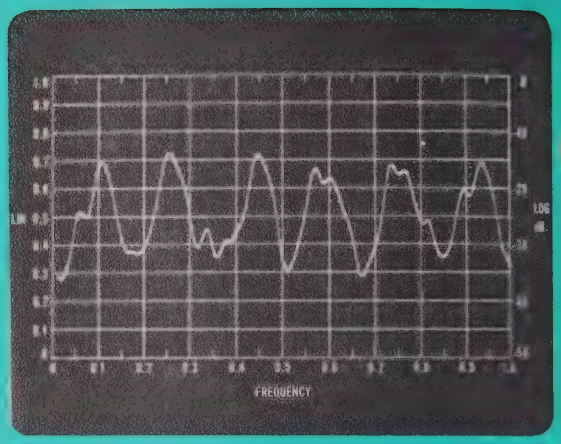


FIGURE 3. DATA VIEWED IN TIME MODE

THEN: View the Spectrum On-Line

Switching the SCOPE to the SPECTRUM mode of operation, the frequency content of the data signal is then displayed over one of nine selected frequency ranges. When analyzing vibration transducer signals, an adjustable intensity marker is furnished for precise identification of the exact frequency where vibration components exist. The intensity marker is super-imposed on the spectrum display. The spectrum display can be selected for either linear or log amplitude. The spectrum, as displayed on the oscilloscope, is always given in terms of linear frequency; however, both linear and logarithmic frequency outputs are available at the rear for external readout or plotting.

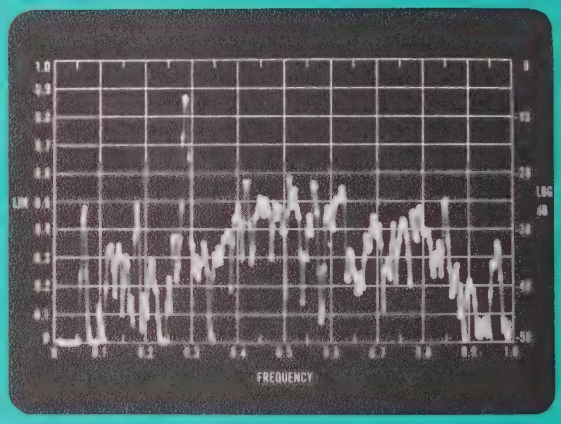


FIGURE 4. DATA VIEWED IN ON-LINE MODE

OR: Add Smoothing to Microphone Data, for example

For unstable signals, or where a large noise contribution is evident, time averaging over a selected number of spectra is done using the averaging controls. The total averaging time is a product of the analysis range memory period and the number of averages selected. If 32 averages were selected on the 1 kHz range and the averaging START button depressed, 8 seconds of averaging would take place. Following the completion of the 32nd contribution to the total spectrum average, the averaging STOP/STORE light illuminates. Selected frequency components in the averaged spectrum can also be located and identified using the adjustable intensity marker.

ALSO: Stay On-Line, but with Smoothing

In a separate mode of operation, exponential averaging can be selected. In the EXPO AVG mode, if 16 averages are selected, the analyzer averages up to 16 and continues averaging with a sliding time constant which emphasizes the contributions of the previous 16 spectra. In this mode, the averaged display is continuously calibrated once the selected number of averages has first been reached. Exponential averaging is stopped by pressing the averaging STOP/STORE control.

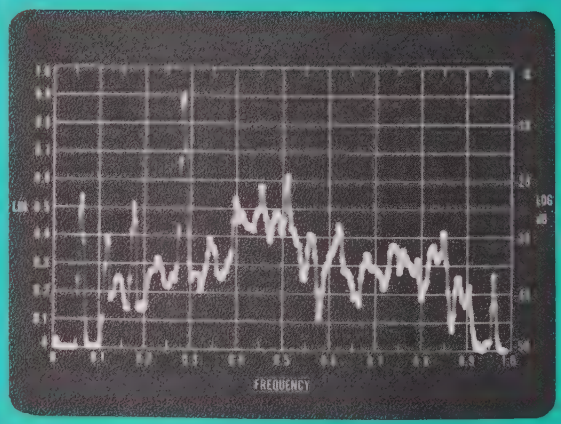


FIGURE 5. DATA VIEWED IN AVERAGER MODE

OR: Monitor the Peak Spectra On-Line.

Machinery start-up vibration may be monitored, for example, by using the averager PEAK HOLD mode of operation. It provides a spectrum display of the highest spectral contribution of each frequency "cell" which exists over a selected time period. Whether the data be transient or changing in frequency, the highest amplitude achieved will be stored. In this mode, the spectrum only updates when higher amplitude than that previously stored comes along. The PEAK HOLD mode remains in operation while the analyzer is in the on-line mode and real time spectra are being observed (AVG button released). Once activated, the PEAK HOLD mode continues to operate until the averaging STOP/STORE control is pressed. Then, by pressing the AVG push button, the peak spectrum can be viewed.

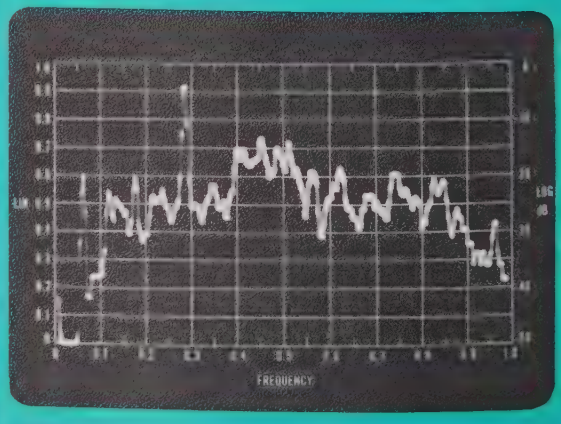


FIGURE 6. DATA VIEWED IN PEAK HOLD MODE

Ideally suited for field work, the fiberglass field case shown is lightweight and strong. Guards protect the latches from accidental opening or damage from bumps. The Model SD44-5 Carrying Case will accommodate the Spectrascope with extra room for small accessory items. Its rugged construction holds up well under the most stringent shipping conditions. The foam lining provides maximum isolation from shock and vibration for its contents.

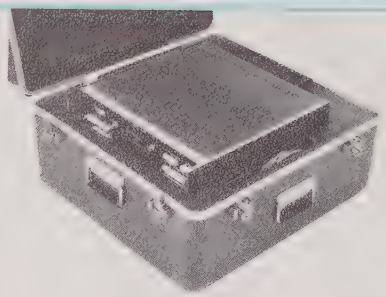


FIGURE 7. CARRYING CASE ADDS TO PORTABILITY

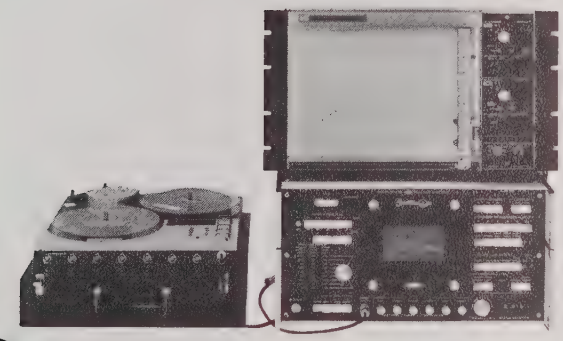


FIGURE 8. TYPICAL INSTRUMENT SETUP

The X-Y recorder provides a popular means for obtaining permanent records of spectrum data processed by the Spectrascope. A typical example of this capability is shown here. Any standard laboratory X-Y recorder can be used with the Spectrascope. An automatic pen-lift feature means that "neat" plots will be generated each time! The pen goes down only when the Plotter Sweep push button has been pressed and then comes up during reset at the end of a plotter sweep. A sweep rate feedback feature controls the X-axis output sweep rate, slowing it down when high amplitude Y-axis or spectral components are experienced so data rate changes do not exceed the mechanical slewing rate of a plotter. Absolute X-axis and Y-axis calibration signals are generated within the Spectrascope for plotter calibration. In both axes, full scale and zero signals are selectable for linear scaling. For logarithmic amplitude scaling, full scale and −10 db signal steps are furnished for calibration to −40 dB. For logarithmic frequency calibration, full scale and −1 and −2 decade levels are easily attained. Data can be plotted either from the basic analyzer memory or from the averager memory. This means that transient, on-line or instantaneous spectrum data can be held in the analyzer memory and a plot generated directly. Averaged and Peak Hold spectrum data can be plotted from the averager memory. An X-Y plot is generated in approximately 25 seconds, plus any time added by sweep rate feedback.

If your task requires gathering a lot of data, a paper tape output record may be the best approach. Averaged or unaveraged data from the Spectrascope may be outputted on a short strip of paper tape using the SD25-140 Paper Tape Control and any standard 8-level punch. The entire analyzed spectrum data is recorded on 500 consecutive punched spaces with additional spaces being used for identification and record markers. A complete spectrum can be punched in less than 30 seconds. This combination lends itself to field applications where data can be gathered for later reduction back at home base. A very simple program and mini-computer may be used to sort the spectrum data or to tabulate the data, listing critical amplitudes and frequencies. Since only 507 characters are required to record the complete spectrum analysis from the Spectrascope, the digital processing of that signal is easily accomplished. (For use with the Paper Tape Control, specify the SD330-3.)

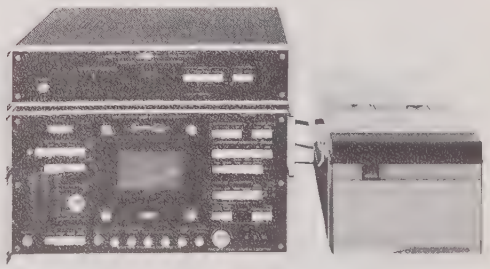


FIGURE 9. SAVE DATA ON PAPER TAPE

The Model SD35-6 D/A-A/D Calibration Fixture shown provides a convenient means for complete checkout and calibration of certain digital ladder circuit plug-in cards in the Spectrascope. In order to perform a full calibration to factory standards, the SD35-6 is required equipment. It also serves as an aid to troubleshooting in the field. Spectral Dynamics Customer Services Department provides complete Spectrascope calibration service as an alternate approach to maintenance requirements.

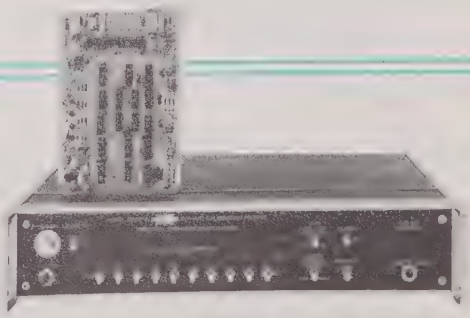


FIGURE 10. AN AID TO SPECTRASCOPE CALIBRATION

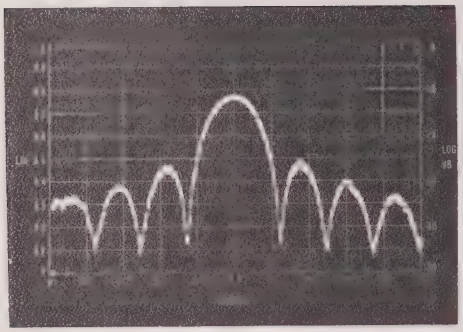


FIGURE 11. THE FOURIER ANALYSIS OF A TRANSIENT

There are two methods for automatically capturing data using the Transient Capture capability of the Spectrascope. One method involves setting an amplitude threshold level, arming the Transient Capture mode circuitry, applying the data and having the amplitude of the data signal trigger the memory Hold mode. Using this technique, only a portion of the full memory can be set to "fill up." This is done by setting the desired number of cells using the Digital Locater control. This has the effect of setting a response time for loading only a chosen "slice" of data in the center of memory. An alternate method involves the application of a memory hold command that is synchronous with the desired data signal. The memory hold command may also be manually applied when HOLD push button is pressed. The picture shows the $\frac{\sin x}{x}$ function which results when four cycles of a 500 Hz tone are captured in memory using the 1000 Hz range of the Spectrascope.

The Peak Hold storage capability provided by the averager portion of the Spectrascope has several noteworthy applications. When selected, the Peak Hold mode provides for storage of the maximum spectral contribution of input data signals that occur until the STOP/STORE push button is pressed. The Peak spectrum only updates in the positive direction or when higher energy is seen within a synthesized filter location than was previously stored. This mode of operation provides one method of capturing transient type data. Figure 12 shows still another application. Here the spectral contribution produced by a vibration transducer mounted to a large electric motor is seen as the motor is energized and brought to operating speed. This method of being able to monitor and store "startup" vibration data has wide applications where rotating machinery is involved.

A unique operational feature of Peak Hold is that the display need not be in the Peak Hold mode while it is actually in operation, storing the peak spectrum for viewing "after the fact." This is accomplished by first pressing the AVG push button, selecting the Averager, and then pressing the PEAK HOLD push button, selecting that mode. Then release the AVG push button, returning the display to the on-line mode for observing data in Real Time. Once the spectrum analysis of the desired event has been observed, pressing the averager STOP/STORE push button prevents further updating of the Peak Hold mode. Then, by pressing the AVG push button, the stored peak spectrum is displayed and may be photographed or plotted on an X-Y recorder.

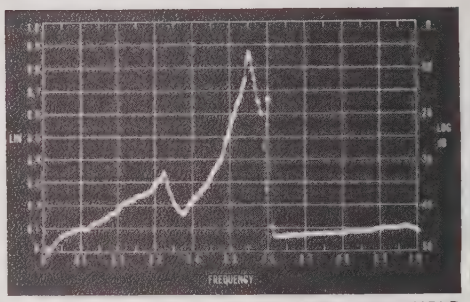


FIGURE 12. START-UP DATA CAPTURED USING PEAK HOLD

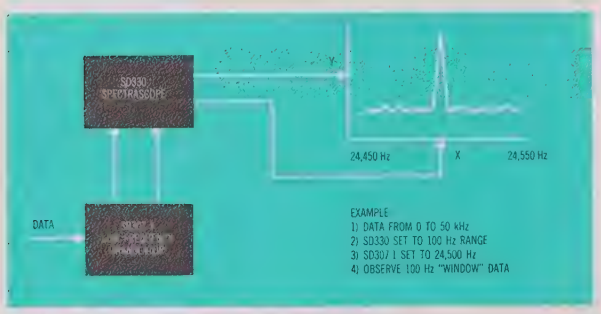


FIGURE 13. "ZOOM-IN" NARROWBAND RESOLUTION

When the Spectrascope is used with a Translator, data as high as 1.5 MHz can be interrogated with the narrow bandwidth filters of the Analyzer. This gives an operator the ability to "zoom in" on a frequency range of interest for discrete analysis with finer resolution. The SD303 Spectrum Translator and the Model SD307-1 Low Frequency Translator are most commonly used with the Spectrascope. The SD303 allows for operation up to 1.5 MHz, using a "window" of 2 k, 5 k, 10 k or 20 kHz on the Spectrascope. Harmonic or spectrum analysis up to 1.5 MHz is made possible with a filter bandwidth as narrow as 12 Hz. The SD307-1 works with the 100, 500, 1,000 and 2,000 Hz ranges of the Spectrascope. It contains its own reference generation via 4-digit front panel thumbwheel switches. Simply dial in a frequency (in 1 Hz steps to 10 kHz or in 10 Hz steps to 50 kHz) and then set the Spectrascope to a desired range, thus achieving spectrum magnification. For example, by setting 24,500 Hz on the Model SD307-1 Translator and selecting the 100 Hz range on the Spectrascope, a 100 Hz "window" is centered at 24,500 Hz. The display on the Spectrascope shows the spectrum analysis from 24,450 Hz to 24,550 Hz using a filter whose bandwidth is 0.6 Hz. The center frequency of the SD307-1 may be selected remotely, lending itself toward automatic system applications. When a range that is not translatable is selected on the Spectrascope, the Translator automatically goes to its Bypass mode.

Shown are a variety of scope graticules, polarized glare shield, bezels and a scope camera that are accessory items to the Spectrascope. The Tektronix C-12 camera and Model 100 Projected Graticule Adapter provide the best oscilloscope pictures and are recommended for best results. Less expensive, more portable cameras may be desirable for field applications. Picture quality depends on the type of camera used.

FIGURE 14. VARIETY OF WAYS TO PRESENT DATA

APPLICATIONS AND ACCESSORIES

The Spectrascope goes where the data is! The picture shows an acoustic survey being conducted at the end of a runway. Power here is derived from a Topaz Model 250 G-12-24-60 Static Inverter operating with a 12 V car battery. Here a Polaroid camera provides the means for recording spectrum data.

FIGURE 15. DATA ACQUISITION IN THE FIELD

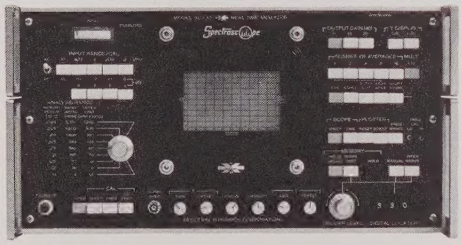


FIGURE 16. SPECIAL PURPOSE SPECTRASCOPE OPTIONS

The Model SD330-1 Spectrascope offers two changes from a standard unit. For applications where it is desirable to work in terms of rpm rather than Hertz, front panel range identification and analyzer filter bandwidth are given in rpm. Input voltage sensitivity is changed from millivolts rms to millivolts p-p. The lowest full scale range of the SD330-1 is 200 millivolts peak-to-peak, lending simplicity to some applications. Another very popular option, the Model SD330-5 offers an external sweep input to the scope display. With two probes located 90° apart on a bearing housing as inputs, machinery shaft whirling motion or "orbits" can be observed.

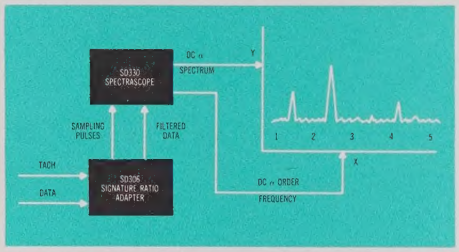


FIGURE 17. VIEW AND PLOT DATA ON ORDER-RELATED FREQUENCY SCALE

The narrowband vibration analysis capability of the Spectrascope is indispensable for establishing the vibration pattern or signature of a turbine or other rotary driven device. One look at the total vibration spectrum often gives a complete picture of possible misalignment, unbalance, improper gear mesh or other **sources** of vibration. However, if speed changes occur during an analysis process or between data taking periods, interpretation of the analyses can become confusing since a full diagnosis requires a close measurement of reference shaft speed (see Figures 18 and 19). A technique does exist for normalizing spectrum data automatically with regard to changes in reference shaft speeds. The result is a spectrum display whose full scale is continually changing frequency but maintaining a constant multiple ratio to running speed. For example, the display can be set to show the spectrum through the 5th or 10th multiple or order frequency. Vibration signatures can be directly compared without regard for minor speed changes. It is also possible to compare spectra produced during two or more runs of the same machine running at different speeds as shown in Figure 20.

One such device, the Model SD306 Signature Ratio® Adapter is illustrated in Figure 17. A speed reference input or tach signal is applied to the SD306 from which a sampling signal for the Spectrascope is developed based on tach rate setting and maximum order settings selected. A built-in tracking low pass or anti-aliasing filter allows the SD306 to be used over a 130/1 speed range. The data signal is applied directly to it for filtering and then applied to the Spectrascope giving a correct, normalized spectrum display free of aliasing terms. A tach sensitivity adjustment is provided for sync of a wide variety of tach signal sources as well as tach levels.

To record amplitude of a specific order as a function of speed change, a voltage proportional to rpm is available. RPM tracking of an order-related vibration component is thus straightforward. Data can be recorded directly on an X-Y recorder calibrated to represent a defined rpm range.

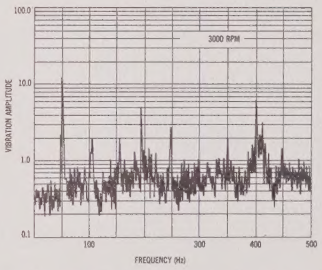


FIGURE 18. TURBINE ANALYSIS AT 3000 RPM

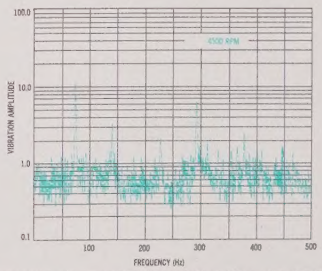


FIGURE 19. TURBINE ANALYSIS AT 4500 RPM

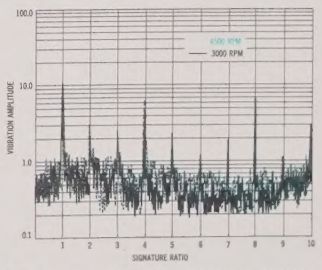


FIGURE 20. TURBINE ANALYSIS USING SIGNATURE RATIO

FIGURE 21. SD25-80-1 3-D DISPLAY CONTROL

A display of amplitude vs frequency vs time can be achieved using the Model SD25-80-1 3-D Display Control (shown) and a storage oscilloscope with the Spectrascope. Many display configurations are possible, including frequency "hole" markers, along with varying display times to optimize data acquisition of time varying events.

SPECIFICATIONS

MODEL SD330 SPECTRASCOPE™

INPUTS

Frequency Range . . . 0.15 Hz to 20,000 Hz in nine selectable ranges as shown in Table I

Frequency Response . . . ±1 dB over entire frequency range

Sensitivity: (for full scale output) . . . . . 0.1 Vrms to 31.6 Vrms adjustable in 1 dB steps

Coupling . . . . . Selectable ac/dc

Level Indication . . . Input monitor meter with overload light

Impedance . . . . . 100 kΩ

Dynamic Range (full scale to minimum discernible signal) . . 48 dB

Noise Level . . . . . 54 dB below full scale

Frequency Markers . . Ten equally spaced frequency markers, switch selectable

OUTPUTS

Internal Scope Monitor
X Axis . . . . . linear frequency or time

Y Axis . . . . . lin or log spectrum or input signal

Memory Contents . . . 300 mV p-p full scale signal displaying the analog replica of the time compressed signal stored in memory

Impedance . . . . . Spectrum and frequency outputs; less than 250 Ω

Spectrum (Y Axis)
Linear . . . . . 0 to 5V (nominal) smoothed output

Log . . . . . 0 to 5V (nominal) log smoothed spectrum output 100 mV/dB)

Frequency (X Axis)
Linear . . . . . 0 to 5V (nominal) smoothed ramp

Log . . . . . 0 to 5V (nominal) full scale smoothed log ramp

Sweep Trigger . . . TTL compatible transition is furnished to synchronize with the start of the sweep

AVERAGER

Modes
AVG . . . . . Selects averaging mode and transfers spectrum display to averager memory.

START . . . . . Performs selected number of averages on a non-redundant basis. Averaging stops when the selected number of averages has been reached. The averaging process is continuously normalized every binary step.

PEAK HOLD . . . . The highest level in each of the 250 filter locations is retained until exceeded. Peak values can be held or erased using front panel controls.

EXPONENTIAL AVG. . . . . . Takes a selected number of averages and once the number of averages has been reached, a flashing light comes on and the exponential averaging continues until an averaging STOP command is given.

STOP/STORE . . . Expo Averaging and Peak Hold is halted when pressed and data is stored in Averager memory. Automatically actuated (indicated by steady light) when linear averaging is completed.

No. of Averages . . . . 1 through 512, selectable in binary sequence

MISCELLANEOUS

Transient Capture Operation . . . . . Number of words selected by thumbwheel switch is loaded into Memory when signal input exceeds threshold set by front panel Trigger Level control. Data is then automatically stored in Memory and the Analyzer reverts to HOLD mode.

Intensity Markers . . . Variable frequency intensity marker is superimposed on spectrum scope display of either real time or averaged data. Adjustable in 1 resolution element increments.

Manual . . . . . Analyzer is tuned in 1000 steps to selected frequency. Tuning adjusted by front panel three-digit thumbwheel selector.

Frequency Linearity . . ±0.4% from best straight line of full analysis range.

Amplitude Linearity . . ±0.5% of full scale or ±1 dB, whichever is greater.

Internal Calibration . Calibrates entire Analyzer from signal input to d-c outputs.

Y Axis . . . . . Log: Full scale to −50 dB in selectable 1 and 10 dB steps.
Lin: Full scale and LIN ZERO selectable.

X Axis . . . . . Log: Full scale to −2 decades in selectable decade steps.
Lin: Full scale and LIN ZERO selectable.

Oscilloscope controls . X-Axis gain and offset
Y-Axis gain and offset
Focus
Intensity

Output Gain (prior to averaging) . . . . . Selectable 0 dB, 10 dB, 20 dB

Output Overload . . . Overload light provided

Display Rates
Oscilloscope . . . . . 50 milliseconds per sweep (20 scans per second)

X-Y Recorder . . . . Display completed nominally in 25 seconds. Plotter rate control is furnished for automatic slowdown during recording of data peaks. Automatically selected to respond to linear or log amplitude display. 1000 frequency axis points are furnished for optimum smoothing. (Separate scope and plotter outputs.)

Power . . . . . 105–125 / 210–250 Vac (switch selectable); 50–400 Hz; ≈150 W.

Dimensions . . . . . Height–22,23 cm (8.75″)
Width (w/furnished rack-adapter tabs)–48,3 cm (19″)
Depth–48,6 cm (20″)
Weight–20,7 kg (≈48 lbs)

ACCESSORIES SUPPLIED

Power cord, multi-pin mating connectors, two manuals and rack-adapter tabs.

PRINTED IN U.S.A.

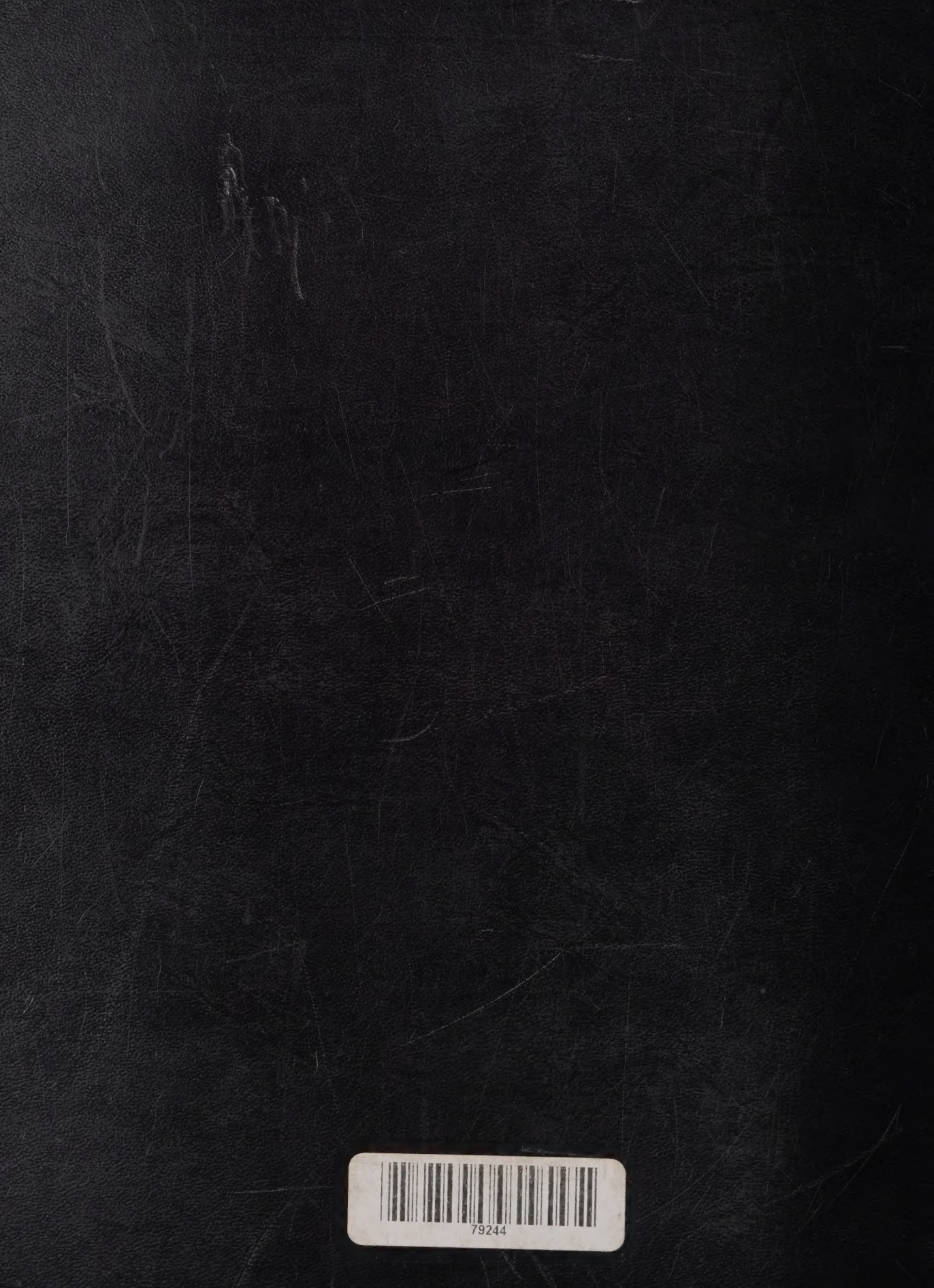
Specifications subject to change without notice

CL-4-73

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

POST OFFICE BOX 671, SAN DIEGO, CALIFORNIA 92112

TELEPHONE 714—278-2501 • TWX 910-335-2022


79244